Section 4

4.0 DESCRIPTION OF EXISTING ENVIRONMENTS

This section describes the existing environment at each of the example sites, in terms of the attributes that were introduced in Section 1.3.3.2. These descriptions include the installations and adjoining areas that may be affected by attribute impacts of Chemical and Biological Defense Program (CBDP) Research, Development, and Acquisition (RDA) activities.

Section 4.1 introduces the environmental attribute analysis methodologies, which are applied to the example sites in Sections 4.2 through 4.7. This provides the basis for analysis of environmental and health consequences of CBDP activities and mitigation measures in Sections 5.2 through 5.12.

4.1 Environmental Attributes

4.1.1 Air Quality

Potential release of chemical or biological agents or other toxins into the atmosphere is an air quality issue for CBDP activities, particularly in connection with aerosol testing. Concentrations of the "criteria pollutants," carbon monoxide (CO), lead, nitrogen oxides (NO_X), ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2), are also of concern. Air quality impacts for criteria pollutants would be significant if CBDP activity at an example site results in emissions that violate the National Ambient Air Quality Standards (NAAQS), aggravate an existing NAAQS violation, or impair air quality within a federally mandated Prevention-of-Significant-Deterioration area. In this section, existing air quality at the example sites is characterized in terms of the regulatory requirements under the Clean Air Act (see Section 2.3.4.1).

Climate and weather are included in the air quality attributes. Air quality affects other attributes, such as biological resources, depending on winds, precipitation, and temperatures.

4.1.2 Biological Resources

Biological resources include plant and animal species and critical or sensitive habitats, as listed in Section 1.3.3.2.b. The distribution and abundance of wildlife within a geographical area are dependent upon the availability of vegetation, water, and shelter and the type and quality of soil. Anthropogenic activities may alter the distribution and abundance of wildlife within an area. Biological resources of concern may be impacted by chemical or biological agents or by other disturbances due to CBDP activity. The Sikes Act Improvement Act of 1997 (16 *United States Code* [USC] 670 *et seq.*) and Department of Defense (DoD) Directive 4700.4, *Natural Resources Management Programs*, require military installations to prepare Installation Natural Resource Management Plans (INRMPs). In this section, biological resources of the existing environment at the example sites are characterized for terrestrial and aquatic resources, critical habitats, and species of special concern.

4.1.3 Cultural Resources

Significant historic sites, architecturally important buildings, archaeological sites, and cultural features are protected by the National Historic Preservation Act of 1966, as amended (16 USC

470 *et seq.*). Significant cultural resources are those that are eligible or potentially eligible for the National Register of Historic Places (NRHP), according to criteria contained in National Park Service regulations (36 *Code of Federal Regulations* [CFR] 60.4). Native Americans may define traditional sites important to their culture as significant, in addition to sites that are on the NRHP. These provisions are implemented through service regulations, as well as through the National Environmental Policy Act (NEPA) of 1969.

In this section, cultural resources of the existing environment are characterized for both historical sites and archaeological sites.

4.1.4 Earth Resources

In this section, Earth resources of the existing environment at the example sites are characterized for topography, geology, soils, and seismic activity. Minerals, fossil fuels, and geothermal energy are also included under Earth resources, as applicable. Chemical or biological materials or other disturbances due to CBDP activity may affect soils. The impacts on other attributes, such as water resources, vary depending on topography and geology.

4.1.5 Land Use

The land use attributes include land use patterns, ownership, planning, and zoning. Impacts on these attributes are secondary impacts that result when current or planned land use is restricted or altered by other attributes, such as noise. Existing land uses for the example sites and locally applicable land use regulations are characterized in this section.

The Coastal Zone Management Act (CZMA) of 1972 (16 USC 1451 et seq, as amended) provides assistance to states, in cooperation with federal and local agencies, for developing land and water use programs in coastal zones. Section 307 of the CZMA stipulates that federal projects that affect land uses, water uses, or coastal resources of a state's coastal zone must be consistent, to the maximum extent practicable, with the enforceable policies of that state's federally-approved coastal management plan. Properties owned by federal government agencies are excluded from the CZMA definition of coastal zone; however, if a proposed federal government activity affects coastal resources or uses beyond the boundaries of the federal property, the CZMA requirement for consistency applies.

The military services have established policies and guidance to ensure that their activities with potential to affect coastal uses or resources are in compliance with the federal consistency provisions of the CZMA. Navy policy, as set forth in OPNAVINST 5090.1B, Chapter 28, *Coastal Zone Management*, 17 October 2002, accepts preparation of an EA or EIS as constituting a "thorough consistency assessment" meeting the requirements for assessment of coastal effects of CZMA Section 307 and its implementing regulations in 15 CFR 930. AFI 32-7064, *Integrated Natural Resources Management*, 1 August 1997, requires that the INRMP for an Air Force installation specifically address consistency with the state's CXM program. AR 200-3, *Natural Resources–Land, Forest and Wildlife Management*, 28 February 1995, requires Army installations and commands to cooperate and coordinate with the coastal states during all phases of the Coastal Zone Management Plan formulation and implementation.

4.1.6 Noise

Noise impacts may affect the health of the workforce and residents and may potentially modify the behavior of domestic animals and wildlife. Noise may have secondary impacts on the land use attributes. Existing noise levels for the example sites and locally applicable noise regulations are characterized in this section.

4.1.7 Socioeconomics and Environmental Justice

The socioeconomic and environmental justice attributes include economic activities, income, population, demographics, and housing. Impacts on these attributes by CBDP activity are secondary impacts that are due to impacts from another attribute area, for example, air quality impacts. This section characterizes the existing socioeconomic and social justice attributes at the example sites.

4.1.8 Transportation and Airspace

The transportation attribute includes highways and roads, railroads, airports, and marine transportation. Impacts on these infrastructure elements by CBDP activity are secondary impacts that are due to impacts from another attribute area, for example, safety, health, and security impacts. This section characterizes the existing transportation attributes at the example sites.

4.1.9 Utilities

The utilities attribute includes facilities and infrastructure for water supply and energy. It does not include collection, treatment, and disposal of wastewater, as noted in Section 1.3.3.2.i. Impacts of CBDP activity on this attribute are secondary impacts that are due to impacts from another attribute area, for example, water resources impacts. This section characterizes the existing utilities attributes at the example sites.

4.1.10 Water Resources

Water resources include surface waters, groundwater, and wetlands, as noted in Section 1.3.3.2.j. This attribute addresses water quality as well as water quantity. Executive Orders 11988 and 11990 and 33 CFR 1977 restrict federal activities in floodplains and wetlands. The National Wetlands Inventory, codified at 40 CFR 6.302 and 47 CFR 1.1307, provides locations and descriptions of wetlands. This section characterizes the existing water resources attributes at the example sites.

4.2 Existing Environmental Attributes at the Edgewood Chemical Biological Center and U.S. Army Medical Research Institute of Chemical Defense (Aberdeen Proving Ground)

The Edgewood Chemical Biological Center (ECBC) and the U.S. Army Medical Research Institute of Chemical Defense (USAMRICD) are located in the Edgewood Area of Aberdeen Proving Ground (APG). The Edgewood Area is mostly within Harford County, south of the City of Edgewood, in northeastern Maryland, as marked on the location map, **Figure 4-1**.

Figure 4-1. Location of the Edgewood Chemical Biological Center and the U.S. Army Medical Research Institute of Chemical Defense

The ECBC and USAMRICD facilities are located on the Gunpowder Neck peninsula, which comprises approximately 5,261 hectares (13,000 acres) of land (USAMRDC 1992). Grace's Quarters, Carroll Island, and Poole's Island are also included in the Edgewood Area of APG. The Edgewood Area is surrounded by Gunpowder River to the west, Bush River to the east, the Chesapeake Bay to the south, and their surrounding floodplains and associated tidal wetlands.

The Edgewood Area is located in the area that was designated in 1917 as the Gunpowder Reservation and used during World War I (WWI) for production of gas shells containing chemical agents. In 1919, the area was renamed the Edgewood Arsenal. During World War II (WWII), vast quantities of munitions were produced at the Edgewood Arsenal. After incorporation into APG in 1971, it became known as the Edgewood Area.

4.2.1 Air Quality

Harford County has a generally moderate climate with mild to hot summers and moderate winters (Maryland State Archives 2001). The Maryland State Climatologist compiled the following temperature data for APG from 1961 through 1990. Seasonal average temperatures at APG ranged from 0.0 degrees Celsius (°C) (32.0 degrees Fahrenheit [°F]) in the winter to 24.6°C (76.3°F) in the summer, with an average annual temperature of 12.9°C (55.2°F). From 1948 through 1998, extreme temperatures were experienced in August (38.9°C [102.0°F]) and in February (-24.4°C [-12.0°F]). Average annual precipitation is 110.29 centimeters (43.42 inches).

The average annual total snowfall is 48.26 centimeters (19 inches), which falls between November and March, according to data collected from 1948 through 1996. The greatest amount of snowfall occurs in January (University of Maryland Department of Meteorology 2001). Prevailing winds are westerly/northwesterly during most of the year, changing to southerly during the summer. The City of Edgewood experiences slight to moderate winds, averaging about 16 kilometers (10 miles) per hour. Strong winds (exceeding 80 kilometers [50 miles] per hour) occur during severe thunderstorms, hurricanes, or intense winter storms (USDA Soil Conservation Service (SCS) 1975).

Harford County is located within the Metropolitan Baltimore Intrastate Air Quality Control Region (AQCR), which has been designated as a severe nonattainment area for O_3 (U.S. EPA Region III 2001). Criteria pollutants monitored around the APG are well below the applicable NAAQS, with the exception of O_3 (USACOE 2000a). Emissions from industrial and vehicular sources in the Baltimore area are identified as the major contributors of O_3 precursors to the atmosphere in the AQCR (U.S. EPA Office of Air Quality Planning and Standards 2001).

Historical hourly average ground-level O_3 (HAGLO) measurements from 1983 to 2000 at the air monitoring station located within the Edgewood Area of APG (approximately 1.8 kilometers [1.1 miles] from ECBC and approximately 2.4 kilometers [1.5 miles] from USAMRICD) ranged from 0.125 parts per million (ppm) to 0.189 ppm and repeatedly exceeded the NAAQS limit of 0.12 ppm for HAGLO (MDE ARMA 2001a).

Existing air pollutant emissions from CBDP activities at ECBC and USAMRICD are discussed in Sections 2.4.1.2.c and 2.4.2.2.c, respectively. Air emissions from the Harford County Waste-to-Energy Plant (WEP) do not exceed acceptable levels set within Maryland Department of the Environment (MDE) Air Permit No. 12-00212 (Poulton 2002). No complaints about odors emanating from ECBC or USAMRICD operations have been reported within the years 1997 through 2001 (Casole 2002a, SBCCOM[1] 2002a).

4.2.2 Biological Resources

The land at APG was almost entirely forested prior to European settlement. Since early colonial times, the land has been cleared and used for agricultural purposes. After 1917, APG allowed some of the land to return to shrubs and forests (Advanced Sciences, Inc. 1990). The Edgewood Area provides a variety of terrestrial and aquatic habitats for a diverse group of animal and plant species. APG consists of about 29,347 hectares (72,516 acres) of land and water, with approximately 17,806 hectares (44,000 acres) comprised of water sources (The Emergency Information Infrastructure Partnership Virtual Forum 2001).

APG is currently updating its 1992 INRMP. The INRMP satisfies the statutory and regulatory mandates discussed in Section 4.1.2, as well as Army Regulation (AR) 200-3, *Environmental Quality Natural Resources-Land, Forest, and Wildlife Management* (USAG 2001). The

[1] The Soldier and Biological Chemical Command (SBCCOM) is referred to throughout this Programmatic EIS; however, it was deactivated in October 2003. The research and development functions of SBCCOM were incorporated into the Research Development and Engineering Command (RDECOM). The Edgewood Chemical and Biological Center (ECBC) is also now a part of RDECOM.

Environmental Conservation and Restoration Division (ECRD) of the Directorate of Safety, Health, and Environment (DSHE) manages ecological matters at APG (USACOE 2000a).

4.2.2.1 Terrestrial Resources

The four major terrestrial habitat types present at APG include woodlands, meadows (cleared areas), swamps, and tidal marshes. There are about 1,479 hectares (3,655 acres) classified as forested lands at the Edgewood Area of APG and approximately 467 hectares (1,154 acres) of lawn/landscaped areas, 224 hectares (553 acres) of building/roads, and 53 hectares (131 acres) of bare soil (USACOE 2000a).

Hardwood trees comprise most of the wooded areas at APG (USAMRDC 1992). The predominant types of trees at APG consist of sweet gum, water oak forest, mixed oak, yellow poplar/transition hardwood, and to a lesser extent, pioneer-type trees (Advanced Sciences, Inc. 1990). The majority of the forested areas also may be classified as wetlands, since the soils are waterlogged due to the high water table. Little virgin woodland remains at APG (Chemical Research, Development, and Engineering Center (CRDEC) 1988).

Meadows that are intensely or periodically mowed cover 34% of APG and consist of various grasses, forbs, and herbaceous weeds, about two-thirds of which are mowed to maximum heights of approximately 0.3 to 1 meter (1 to 3 feet) once or twice a year and the remaining one-third of which is mowed more frequently to a maximum height of approximately 15 centimeters (6 inches) (Advanced Sciences, Inc. 1990). Approximately 344 hectares (850 acres) of old fields and 281 hectares (694 acres) of short-grass ranges are found at the Edgewood Area of APG (USACOE 2000a).

Approximately 24 mammal species have been recorded at APG, and potential habitats may exist for 16 additional species at APG. The most common mammals at APG include the following: eastern chipmunk, eastern cottontail rabbit, raccoon, woodchuck, eastern pipstrelle, flying squirrel, little brown bat, masked shrew, muskrat, gray squirrel, beaver, Norway rat, opossum, short-haired bat, striped skunk, white-footed mouse, and white-tailed deer (Advanced Sciences, Inc. 1990, USACOE 2000a). Trapping and hunting for deer, muskrat, raccoon, red fox, opossum, skunk, and otter are used to manage wildlife populations. Recent harvests of white-tailed deer were between 650 and 1,200 (USACOE 2000a). Between 1987 and 1989, more than 4,000 muskrat were trapped. Hunting and trapping activities at APG are subject to APG Regulation 210-6, *Installation Recreational Hunting and Trapping on Aberdeen Proving Ground*, and various state and federal laws (USAMRDC 1992); however, since 11 September 2001, hunting and trapping have been prohibited on APG grounds.

APG provides suitable habitats for more than 40 species of reptiles and amphibians (DA 1987). Commonly occurring amphibians include the bullfrog, green frog, northern cricket frog, northern spring pepper, southern leopard frog, Fowler's toad, and red-backed salamander. Commonly occurring reptiles include spotted turtle, eastern mud turtle, common snapping turtle, eastern box turtle, northern water snake, and eastern garter snake (USACOE 2000a). The majority of reptiles and amphibians are dependent upon temporary pools and wetlands as a feeding habitat and/or during the larval phase of their life cycle. Amphibians and reptiles serve as important food sources for some mammals and raptorial birds. Frogs, turtles, and snakes occur mostly in

wetland habitats and inundated old bomb craters. Salamanders are found in moist habitats near marshes and beaver ponds. The majority of amphibians and reptiles become inconspicuous during the winter, as they burrow underground or in marsh sediments (USAMRDC 1992).

Approximately 250 species of birds inhabit APG throughout the year. Bird species that occur on a seasonal basis at APG include the mallard, lesser scaup, ring-billed gull, mourning dove, red-bellied woodpecker, downy woodpecker, barn swallow, Carolina chickadee, Carolina wren, American robin, European starling, northern cardinal, song sparrow, red-winged blackbird, and common grackle (USACOE 2000a).

Waterfowl species that breed in various areas of APG include the black duck, blue-winged teal, Canada goose, hooded merganser, mallard, and wood duck. The most abundant waterfowl species at APG is the Canada goose. APG has allowed the following waterfowl species to be hunted on its premises: the black duck, canvasback, lesser scaup, mallard, wood duck, and redhead (GPC 1992). Detailed information associated with colonial birds, raptors, and neotropical migrant birds is found in the *Aberdeen Proving Ground Mission Environmental Impact Statement* (*APG Mission EIS*), November 2000 (USACOE 2000a).

4.2.2.2 Aquatic Resources

Aquatic habitats at APG include the estuaries of the Chesapeake Bay, Bush River, Gunpowder River, smaller freshwater creeks, on-site tidal and nontidal streams, beaver ponds, ponds in nontidal freshwater marshes, man-made permanent or seasonally flooded ponds, and wetlands (USACOE 2000a). APG is situated at the freshwater-saltwater interface portion of the Chesapeake Bay. Nearly half of the freshwater input to the Chesapeake Bay is provided by the Susquehanna River, which strongly influences variations in flow, sedimentation, nutrients, and pollutants within the Chesapeake Bay ecosystem. A major portion of the food web in this ecosystem is nourished by major accumulations of organic material adsorbed to the sediment brought into the bay. The marsh areas associated with the estuary provide habitats for shrimp, crabs, fish, and other estuarine organisms. APG provides freshwater, brackish, and marine environments for a wide variety of fish species. The interface of open water and terrestrial habitats creates regions known as mud flats, which are used by various bird and mammal species during periods of low tide when land is exposed (USAMRDC 1992).

The most common aquatic habitats in the Edgewood Area of APG include small freshwater creeks draining low-lying marsh areas and low-salinity estuaries. Long-term degradation consequences have lowered the number of aquatic species in Wright Creek and Canal Creek (CRDEC 1988). The main facilities of ECBC and USAMRICD are located near King's Creek, Lauderick Creek, and Bush River.

The aquatic flora at APG includes algae and submerged aquatic vegetation, which occur in several areas of the Chesapeake Bay surrounding APG (USACOE 2000a). Excessive phytoplankton, caused by high nutrient loads, decreases the amount of submerged vegetation by providing unsuitable living conditions, such as reduced water clarity and dissolved oxygen levels. These negative consequences impair growth and survival of submerged aquatic vegetation and other deeper aquatic species (Orth et al. 1991, Sellner 1993). Approximately 242,814 hectares (600,000 acres) of submerged aquatic vegetation were once present in the

shallow areas of the Chesapeake Bay; however, due to increased nutrient and sediment loads, the amount decreased to 15,433 hectares (38,135 acres) in 1984. In 1994, the amount of submerged aquatic vegetation increased to 25,900 hectares (64,000 acres) (Blankenship 1995). It was determined that APG was not a direct influence on the fluctuations in the amount of submerged aquatic vegetation in the upper Chesapeake Bay. The following submerged aquatic species were identified in APG estuarine waters in 1990: common elodea, coontail, curly pondweed, Eurasian watermilfoil, horned pondweed, hydrilla, muskgrass, naiad (*najas gracillima* and *naja minor*), redhead grass, sago pondweed, southern naiad, water stargrass, widgeon grass, and wild celery (USACOE 2000a).

The aquatic fauna at APG include zooplankton, benthic invertebrates, and fish. Zooplankton found within the Chesapeake Bay includes cladocerans, copepods, larval crustaceans, and rotifers. Zooplankton serves as a source of food for larval and juvenile fishes and other estuarine organisms. Benthic invertebrates are important in improving water quality by removing phytoplankton and suspended particles, by recycling nutrients via food web interactions and sediment mixing, by serving as food for higher trophic levels, and by affecting contaminant transport in the ecosystem through sediment mixing and food chain transfers to other organisms (Dauer et al. 1993). The only invertebrate of major commercial and recreational importance within APG waters is the blue crab, which is also significant as a food source for other species and as a consumer of other species within the Chesapeake Bay (Van Heukelem 1991). Approximately 50 fish species are present or could occur in the Chesapeake Bay (GPC 1992). Detailed information associated with the fish populations are presented in the *APG Mission EIS* (USACOE 2000a).

4.2.2.3 Critical Habitats and Species of Special Concern

Ten threatened or endangered animal species occur or could occur at APG, including the puritan tiger beetle, northeastern beach tiger beetle, Maryland darter, shortnose sturgeon, Atlantic sturgeon, peregrine falcon, least bittern, northern harrier, black rail, and bald eagle (Wolfin 1994, USFWS 1993a, McKegg 1994, Daniel 1994). The puritan tiger beetle and northeastern beach tiger beetle have not been identified at APG (Knisely 1997). APG has not identified the federally-listed and state-listed endangered Maryland darter within its boundaries (SWCA, Inc. 1994). The shortnose sturgeon is found in all areas of the Chesapeake Bay (Schwartz 1964, Jenkins and Burkhead 1994); however, it has not been captured recently in or near APG waters (Wolfin 1994, USFWS 1993a, McKegg 1994, Daniel 1994). A shortnose sturgeon species management plan is being created by APG (USACOE 2000a). The Atlantic sturgeon has not been found in the waters near or at APG (Wolfin 1994, USFWS 1993a, McKegg 1994, Daniel 1994). The peregrine falcon does not inhabit APG on a regular or irregular basis (SWCA, Inc. 1994). The least bittern, northern harrier, and black rail may occur at APG, but have not been identified to date (USACOE 2000a).

The only known species of special concern to permanently inhabit APG is the bald eagle *(Haliaeetus cephalus)*, a federally-listed threatened and state-listed endangered species (SWCA, Inc. 1994). APG contains high concentrations of bald eagles because high-quality habitats, food, and nesting sites are abundant. Habitats of bald eagles are characterized as timberland areas near streams and the shore areas along the Chesapeake Bay (USAMRDC 1992). Bald eagles also use

the Chesapeake Bay during migration. Dichloro-diphenyl-trichloroethane (DDT) and other contaminants have impacted reproduction activities, particularly during the 1960s (SWCA, Inc. 1994). The increase in the bald eagle population since DDT was banned has led the species to be reclassified as federally threatened instead of federally endangered (USFWS 1995a).

To prevent adverse impacts on bald eagle populations on the APG installation, the APG's U.S. Army Garrison (USAG) created the Endangered Species Protection Plan, which minimizes disturbance during nesting and breeding. The most critical period for bald eagles occurs during courtship and egg incubation, generally from 1 January to 15 April. USAG personnel monitor the nest sites of bald eagles (USAMRDC 1992). No APG activities or personnel are allowed within a 500-meter (approximately 0.3-mile) radius, and human activity is restricted within a 1,000-meter (0.62-mile) radius of a bald eagle nesting tree (USACOE 2000a, Pottie 2002). Removal of the nesting trees within the 500-meter (0.3-mile) protected areas is prohibited. If work must be conducted in these special areas, it has to be done outside of the nesting season (15 December to 15 June) (Pottie 2002). APG promotes the improvement of the bald eagle habitat through management of perch availability and prey species (USAMRDC 1992). The APG Bald Eagle Management Plan mandates review of all proposed projects at APG for potential impacts on bald eagles. APG identified 101 eagles in 1995. Nesting areas of bald eagles are found along the southern portion of the Edgewood Area, along the northeastern side of the northern portion of the Edgewood Area, and about 0.7 kilometers (0.4 miles) northeast of Wilson Point on the Edgewood Area of APG. The nearest ECBC or USAMRICD facility to a bald eagle nesting area is 500 meters (about 0.3 miles) from the nesting area near Wilson Point (Pottie 2002). None of the other Maryland-listed endangered or threatened species or species of special concern are known to frequent areas directly near ECBC or USAMRICD (McKegg 1991, USACOE 2000a).

Two types of plant species identified at APG, the slender blue flag and the mudwort, have been listed as endangered by the State of Maryland. The slender blue flag commonly occurs in brackish and freshwater marshes, sands, shores, meadows, damp meadows, and swamps, and infrequently occurs in seasonally flooded forests and marshes with scattered trees at APG. The mudwort occurs in brackish sand and mud, tidal brackish and freshwater marshes, and tidal fresh to brackish muddy or sandy shores. It has been found in disturbed areas of APG (Johnson et al. 1995, Fernald 1987, Gleason and Cronquist 1991, Tiner 1993). Three additional endangered or threatened species identified at properties adjacent to APG include the giant cane, Parker's pipewort, and toothed sedge. Although APG may provide suitable habitats for them, none of these species have been found on the installation (DA 1981, Johnson et al. 1995).

Special status bird species at APG include waterfowl, colonial birds, raptors, and neotropical migrant birds. Wintering habitats of 29 waterfowl species within the APG region of the Chesapeake Bay are protected. The U.S. Fish and Wildlife Service (USFWS) and DoD created the North American Waterfowl Management Plan, which established several waterfowl refuges called the APG Waterfowl Sanctuary System. Hunting is prohibited in the refuges, which provide nesting and feeding areas for waterfowl (GPC 1992, Forsell 1994).

4.2.3 Cultural Resources

APG complies with the benchmark regulations for cultural resources and is preparing an Integrated Cultural Resources Management Plan. The DSHE ECRD manages the cultural resources at APG, and the Cultural Resource Manager and the State Historical Preservation Office must approve any construction or development activities within the vicinity of significant cultural resource sites at APG. The party seeking to develop or renovate on APG is required to conduct a preinvestigation in the proposed site, search for archaeological features or objects, and provide potential items to the Cultural Resource Manager. The Cultural Resource Manager will then submit these items to the State Historical Preservation Office for verification of archaeological items. A project will not proceed without the approval of the Cultural Resources Manager and the State Historical Preservation Office (Gallihue 2002a).

Seventy-five structures in Harford County are listed on the NRHP (National Park Service (NPS) 2001). Within APG boundaries, 1,059 pre-1951 historic structures (including 451 buildings in the Edgewood Area), 14 historic archaeological sites, and 46 prehistoric archaeological sites have been identified (USACOE 2000a, Goodwin and Associates 1996). Systematic field surveys have been performed on less than 1% of these sites, and it is likely that other archaeological sites are present at APG (USACOE 2000a).

4.2.3.1 Historical Sites

There are three historically significant sites on the Edgewood Area of APG (NPS 2001). Two are listed on the NRHP and one has been nominated; however, none of these historical resources are located within or adjacent to USAMRICD or ECBC facilities. Gunpowder Meetinghouse, built in 1773, is located on Magnolia Road. The Presbury Meetinghouse (also known as the Quiet Lodge and the Presbury family home) was built in 1740 and has been used as officers' quarters. This building is located on Austin Road. The third historic building in the Edgewood Area, Poole's Lighthouse, has been nominated for the NRHP, but is not listed as of 2001. Constructed in 1825, this building is located on the northwest side of Poole's Island (NPS 2001, USACOE 2000a).

The Presbury Church located on Gunpowder Neck peninsula is eligible for the NRHP. It was partially constructed in 1772 and finished in 1889. Although the church has not been used since 1919, it may be the oldest standing Methodist church in the United States (CRDEC 1988). Four other buildings that were constructed after the establishment of APG, the Fort Hoyle Riding Hall and three chemical weapons facilities, are eligible for the NRHP (USACOE 2000a). Two USAMRICD buildings and one ECBC building also have been identified as historic (Gallihue 2002b). These buildings, illustrative of military activities during the cold war, are being surveyed (USACOE 2000a).

4.2.3.2 Archaeological Sites

It has been determined that humans have occupied APG since approximately 11,500 B.C. Previous work extensively described historical components of the Native Americans at APG (Klein 1988). A total of 46 prehistoric archaeological sites were identified at Edgewood and Aberdeen Areas of APG through the mid-20th century by amateurs (Marye 1938, Marye 1957a-c, USACOE 2000a). Little is known about these sites because of poor documentation

(Envirosphere Company 1988). Found mostly in coastal locations, 43 of the 46 prehistoric archaeological sites are located within about 50 meters (164 feet) of the shoreline or streams (Goodwin and Associates 1996). The prehistoric sites identified at APG include 2 from the Paleoindian period (approximately 12,000 to 8,500 years ago), 8 from the Archaic period (approximately 8,500 to 3,000 years ago), 10 from the Early-Middle Woodland period (3,000 to more than 500 years ago), and 13 from the Late Woodland and Contact period (less than 3,000 to less than 500 years ago). Some sites had remains assigned to more than one time period, and 38 sites could not be differentiated by time period. The prehistoric sites were characterized as: 14 shell middens (3 containing lithic scatters), 19 lithic scatters, and 7 containing pottery. Eight sites had practically no available information. None of these prehistoric archaeological sites are deemed eligible for the NRHP (USACOE 2000a).

Fourteen historic archaeological sites have been identified at APG. These sites mostly constitute trash scatters and other features and artifacts from the historic period that are not presented on historic maps. Remains from the 17th or 18th centuries have been identified at five of the sites, while seven sites contain 19th- or early-20th-century remains (Goodwin and Associates 1996). None of these historic archaeological sites are considered eligible for the NRHP (USACOE 2000a). In addition, 487 potential historic archaeological sites have been identified at APG using historic maps of various ages. These sites included former residences, farmhouses and associated outbuildings, schools, churches, and other structures built in the 18th and 19th centuries (Envirosphere Company 1988, Goodwin and Associates 1996). Traditional cultural properties are being surveyed at APG to identify Native American sacred and traditional culture sites (USACOE 2000a).

The Edgewood Area of APG contains numerous archaeological sites predominantly of early colonial and Native American origin. The Division of Archaeology of the Maryland Geological Survey has files for 44 of the 60 known prehistoric and historic cultural resource sites, including a fossil site that is rare in the eastern seaboard (USAMRDC 1992). At least 20 known or suspected archaeological sites lie within a 0.8-kilometer (0.5-mile) radius of the main ECBC and USAMRICD buildings (Gallihue 2002b).

4.2.4 Earth Resources

4.2.4.1 Topography

Harford County is divided into two physiographic provinces. Approximately 75% of its area (the northern, western, and central portions) is located in the Upland Section of the Piedmont Plateau Physiographic Province, which consists of flat-lying lowlands with some low knobs and ridges and uplands with shallow valleys and low, rounded hills of moderate relief and altitude. The remaining 25% of Harford County (the southeastern portion) is found in the Western Shore Lowlands Region of the Coastal Plain Physiographic Province (MGS 2001a, USDA SCS 1975), a flat, seaward-sloping lowland (Trapp and Horn 1997), with land dipping eastward at generally less than 1 degree (MGS 2001a). The boundary between these two provinces is known as the Fall Line, since falls and rapids form where streams cross the contact between the Piedmont's consolidated rocks and the soft unconsolidated Coastal Plain sediments (Trapp and Horn 1997). The Fall Line crosses the southeastern portion of Harford County, extending from the mouth of the Susquehanna River southwestward to near the mouth of Gunpowder River. The Edgewood

Area of APG is located approximately 4.8 kilometers (3 miles) southeast of the Fall Line (MGS 2001a).

Surface elevations are lower in the Coastal Plain Physiographic Province than in the Piedmont Plateau Physiographic Province. The highest surface elevation in Harford County is about 245 meters (803 feet) above mean sea level (AMSL) at Slate Ridge in Whiteford, Maryland, in the northern portion of the County and within the Piedmont Plateau (Bock 2001). Elevations in the Atlantic Coastal Plain can exceed approximately 122 meters (400 feet) near the Fall Line. The southern portion of the Coastal Plain is a broad lowland that ranges in elevation from about 27 meters (90 feet) AMSL near Aberdeen to sea level near the Chesapeake Bay (USDA SCS 1975). The Gunpowder Neck peninsula, including the Edgewood Area of APG, lies within the Coastal Plain Physiographic Province, characterized as generally flat with elevations rarely exceeding approximately 6 meters (20 feet) above sea level. The highest elevation there is about 15 meters (50 feet) AMSL, in the extreme northwest portion of the Edgewood Area. Surface elevations of the land where the ECBC and USAMRICD facilities are located vary between about 3 to 6 meters (10 to 20 feet) AMSL (U.S. Geological Survey (USGS) 1985).

4.2.4.2 Geology

The regional geology underlying the Edgewood Area consists predominantly of Quaternary Lowland Deposits. Part of the northern portion of the Edgewood Area consists of Cretaceous Age unconsolidated rock of the Potomac Group. The Quaternary Lowland Deposits consist of medium- to coarse-grained sand and gravel, multicolored silt and clay, brown to dark brown lignitic silty clay, and reworked Eocene glauconite. Cobbles and boulders are found near the base of this unconsolidated formation. The thickness of the Quaternary Lowland Deposits ranges from 0 to about 46 meters (0 to 150 feet). The Potomac Group is divided into the following three subgroups: the Raritan and Patapsco Formations, Arundel Clay, and Patuxent Formation. The Raritan and Patapsco Formations consist of gray, brown, and red multicolored silts and clay, lenticular, cross-bedded, argillaceous subrounded sands, and minor gravels, with a maximum thickness of approximately 122 meters (400 feet). The Arundel Clay consists of dark gray and maroon lignitic clay with abundant siderite concretions and has a maximum thickness of about 30 meters (100 feet). The Patuxent Formation consists of white or light gray to orange brown, moderately sorted, cross-bedded, argillaceous, angular sands and subrounded quartz gravels, pale gray silts and clay, with a maximum thickness of about 76 meters (250 feet) (MGS 2001b).

4.2.4.3 Soils

The Edgewood Area of APG and its associated soils are not included in the Soil Survey of Harford County (USDA SCS 1975); however, a soil map for APG was prepared by the U.S. Army Corps of Engineers (USACOE), Baltimore District, and was verified by a limited sampling effort. The Edgewood Area was difficult to sample for characterization purposes due to soil contamination and restricted access (Advanced Sciences, Inc. 1990).

There are four major soil series found in the Edgewood Area, including Sassafras Series, Keyport Series, Elkton Series, and Marsh sediment (Advanced Sciences, Inc. 1990). The soils of the Sassafras, Keyport, and Elkton Series originated in old marine deposits. The Sassafras Series

consists of deep, well-drained, gently sloping to steep, sandy soils with moderate amounts of silt and clay that occur on short steeper slopes and undulating uplands of the Coastal Plain. These soils have moderate permeability and moderate to high water-capacity availability. The Keyport Series consists of deep, moderately well-drained, nearly level and gently sloping, clayey and silty soils that occur on uplands of the Coastal Plain. The Elkton Series consists of deep, poorly drained, nearly level clayey soils that occur on the upland, interfluvial flats of the Coastal Plain. Soils in both the Keyport and Elkton Series have low permeability and high water-capacity availability (USDA SCS 1975). The fourth type of soil/sediment is Marsh sediment. Both meadow and tidal marsh sediment are found in the Edgewood Area and constitute mixtures of soil types that represent more of a soil condition than a soil type. The marsh sediment in the meadow areas consist of brackish to saline peat, which formed in poorly drained alluvial material along streams and drainage ways. The marsh sediment in the tidal areas consists of salty clay loam developed in wet, marshy land along lower reaches of streams and Chesapeake Bay estuaries (Advanced Sciences, Inc. 1990).

ECBC and USAMRICD facilities are located mostly within the Canal Creek Study Area, which is part of the Installation Restoration Program (IRP) for APG. Forty-seven IRP sites are identified in this study area and arranged into 35 operational clusters. With respect to facilities conducting CBDP-related activities, one IRP site associated with USAMRICD and five IRPs associated with ECBC were reviewed in the *Canal Creek Study Area Remedial Investigation Report (RI Report)*, September 1995, which identified areas of environmental concern and general soil quality conditions within the ECBC and USAMRICD areas (Jacobs Engineering Group, Inc. 1995).

USAMRICD facilities originally discharged laboratory waste to chemical sewers that had outfall discharge points located in drainage ditches and in King's Creek marsh areas immediately northeast, east, and southeast of the IRP sites. These wastewater discharge points were mostly eliminated by the mid-1970s, and septic systems have been constructed for some of these buildings. Hazardous waste storage associated with agent-related work is another environmental concern with these facilities. The 1995 *RI Report* included evaluation of chemical analysis data for several surface soil and sediment samples collected near these facilities. Surface soil samples collected near the USAMRICD IRP sites exceeded the risk-based threshold concentration (RBTC) levels for arsenic and lead and had detectable concentrations of acetone, toluene, polynuclear aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs). Sediments collected at the sewer outfalls and drainage ditches where USAMRICD previously discharged laboratory waste had PAHs and metals exceeding their respective RBTC levels, as well as detectable concentrations of pesticides (Jacobs Engineering Group 1995).

There are 11 IRP sites associated with ECBC facilities conducting CBDP-related activities. The environmental concerns associated with these sites include potential disposal of agent-contaminated waste or hazardous chemicals into a former waste disposal pit, former sewer systems, drainage ditches, wastewater holding tanks, or discharge points in a nearby creek, or onto the ground surface. Other areas of environmental concern include potentially contaminated areas at hazardous waste storage sites and facilities, former drum storage areas, and agent testing facilities. The 1995 *RI Report* indicated that some of the soil samples had concentrations exceeding their respective RBTC action levels for PCBs, arsenic, PAHs, and various metals, and

some sediment samples contained exceedances of PCBs, pesticides, and metals. Other constituents detected in some sediment and soil samples include explosives (Rapid Detonating Explosive [hexahydro-1,3,5-trinitro-x-triazine] and diisopropylmethyl phosphonate), nerve-agent degradation products, pesticides, dioxins, furans, and chlorinated volatile organic compounds (VOCs) (Jacobs Engineering Group 1995).

The chief mineral resources in the Coastal Plain Physiographic Province are sand and gravel that are used as aggregate materials in the construction industry (MGS 2001a). Crystalline rocks, including crushed stone and granite materials, are the principal mineral resources found in the Piedmont Plateau Physiographic Province (Harford County 1996). Other mineral sources found mostly near the Fall Line in Harford County include clay, talc, serpentinite, basalt, and marble (USDA SCS 1975).

4.2.4.4 Seismic Activity

Several faults exist within the State of Maryland; however, they are believed to be inactive (Bollinger 1969). Earthquakes in the Atlantic Coastal Plain are associated with nearly vertical faults that originated during the Triassic period upon the opening of the Atlantic Ocean, which occurred 220 million years ago. The Atlantic Ocean has remained in the same location since the Triassic period (Hanks 1985).

4.2.5 Land Use

The land area in Harford County comprises about 95, 376 hectares (235,676 acres). The northern and central portions of the county are mostly agricultural and rural residential, with few state and county parks. The land use within and surrounding the cities of Aberdeen, Edgewood, and Bel Air include medium- to high-density residential and industrial areas, with few state and county parks. These types of land use are also found along the northern border (Amtrak railway) of the Edgewood Area of APG. The extreme southern portion of Harford County consists of the APG and surrounding water sources, including King's Creek, Lauderick Creek, Gunpowder River, Bush River, and the Chesapeake Bay (Harford County 1996).

The *Aberdeen Proving Ground Land Use Assessment Plan* (USACOE 1998) provides a detailed description of the land use patterns on APG. Large portions of the APG area have been contaminated by historic ordnance and chemical agent testing, and by disposal practices for residues from these testing activities (USAMRDC 1992). In 1984, APG was proposed for the National Priority List (NPL) because the hazardous waste sites were deemed to be the most in need of remediation efforts by the U.S. Environmental Protection Agency (EPA). On 21 February 1990, APG was officially placed on the NPL (Hurst 1992).

An estimated 4 million unexploded rounds and 1 million inert rounds have not been recovered from APG ordnance testing activities since 1917, including impact testing of chemical agents. Access is restricted for the majority of the APG land area because of the unrecovered materials (Harmon Hash, as cited in Advanced Sciences, Inc. 1990).

Current land use within the Edgewood Area is primarily for materiel testing, laboratory research, and military training (USACOE 2000a). Presently, ordnance and vehicular testing are conducted

on more than 80% of APG. Consequently, access is limited to most areas on the installation due to past and present activities at APG (USAMRDC 1992). Current ECBC and USAMRICD facilities and activities are described in Sections 2.4.1 and 2.4.2, respectively.

The State of Maryland's Chesapeake Bay Critical Area (CBCA) Act of 1974 established protection zones that limit or exclude development along the shores of the Bay and its tributaries to protect the Bay from degradation by human activities. APG uses NEPA review procedures and close coordination with MDNR for all projects to limit adverse impacts to the environment, with particular attention to the Bay (USACOE 1998).

The CBCA law empowers counties to develop their own CBCA plans. APG owns over 90% of Harford County's shore line and is not legally bound to abide by the County's CBCA plan. The County provides comments on APG projects during the NEPA process, but it cannot enforce policy on them. APG's CBCA policy is understood to comprise adherence to the CBCA program unless mission requirements would be affected or excessive expense would be incurred. This policy follows State of Maryland guidelines and includes a NEPA procedure for review of any action that expends federal funds. The procedure includes, as a minimum, impacts associated with Coastal Zone Management, overall land use, wildlife, endangered species, sediment and erosion, historical and archaeological resources, hazardous materials, and asbestos (USACOE 1998).

4.2.6 Noise

The most significant sources of noise generated in the Edgewood Area comprise blasts and vibrations from weapons testing (artillery firing and explosive demolitions) in the central and southern portions of Gunpowder Neck peninsula, helicopter operations from Weide Army Helipad (WAH), and aircraft flyovers. Relative to these sources, APG tenant facilities in the northern portion of Gunpowder Neck peninsula, including ECBC and USAMRICD, produce insignificant levels of noise. Other minor sources of noise include traffic; construction, demolition, and maintenance activities; small arms firing at field training exercises; and noise from Amtrak rail systems west of APG. Aircraft flights and vehicle movement at test tracks also produce minor amounts of noise. Off-post sources of noise include blasts along the Eastern Shore of Maryland from ordnance fired over the Chesapeake Bay (USACOE 2000a).

There have been no complaints regarding noise associated with CBDP-related activities conducted at USAMRICD or ECBC (Casole 2002b, SBCCOM 2002a).

4.2.7 Socioeconomics and Environmental Justice

4.2.7.1 Economic Activity

Approximately 4,500 businesses operate in Harford County (Maryland Department of Business and Economic Development 2001). Although agricultural, mining, and federal government (military) jobs have decreased, economic growth has occurred in the wholesale trade, service, and construction sectors (USACOE 2000a). Unemployment in Harford County was 3.4% in March 2001 (Harford County Office of Economic Development 2001).

The majority of APG employees and their families reside, spend their income, and use their benefits in Harford County (USACOE 2000a). APG is the single largest employer in Harford County, accounting for 9.5% of the employed civilian labor force (Harford County Office of Economic Development 2001). The workers assigned for CBDP activities comprise approximately 9.1% of the total personnel (USAMRICD 2001b, ECBC 2001c).

Federal civilian and military employee earnings in Harford County amounted to 21% during 1999 (Maryland Department of Labor, Licensing, and Regulation 2002). APG's $545.4 million payroll serves as a dominant economic force in northeastern Maryland (APG 2002).

4.2.7.2 Income

According to 1997 model-based estimates, the median household income in Harford County was $52,231, and 6.4% of the population in Harford County were below the poverty level (U.S. Census Bureau 2001).

4.2.7.3 Population and Demographics

According to the 2000 U.S. Census, the population of Harford County was 218,590, consisting of 86.8% white, 9.3% black, 1.5% Asian, 0.2% Native American and Alaskan Native, and less than 0.1% Native Hawaiian and other Pacific Islander. Approximately 0.7% were listed as some other race and 1.5% as two or more races. The Hispanic population, who may be listed as any race, accounted for 1.9% of the County total (U.S. Census Bureau 2001).

4.2.7.4 Housing

In 2000, the average price for a new home in Harford County was $147,725 (Harford County Office of Economic Development 2001).

4.2.8 Transportation and Airspace

4.2.8.1 Highways and Roads

Several roads provide vehicular access to the Edgewood Area. Interstate Route 95 (I-95), a major southwest-northeast regional freeway located approximately 4.8 kilometers (3 miles) north of the Edgewood Area, connects APG with Baltimore and Washington, D.C., to the southwest and Philadelphia to the northeast. Parallel to I-95 is U.S. Route (USR) 40, which is approximately 3.2 kilometers (2 miles) north of the Edgewood Area. Direct access to the Edgewood Area of APG is gained via State Route (SR) 24 and SR 152, which are north-south trending state roads. Both I-95 and USR 40 have exits directly leading to SR 24 and SR 152. SR 24 (Emmorton Road) provides direct access to the Main Gate of the Edgewood Area. SR 152 (Magnolia Road) leads directly to the Magnolia Road Gate, which provides limited access to the post. A third gate, the Edgewood Gate, is located directly off SR 755 (USACOE 2000a). Ground transportation is also available via Greyhound bus service from the Town of Aberdeen to APG (USAMRDC 1992).

In 1994, a traffic study indicated that an average of 7,396 vehicles enter or leave the Edgewood Area on a daily basis. Approximately 65% of the vehicles pass through the Main Gate, while the remaining 35% pass through Edgewood Gate. During this traffic study, the Magnolia Road Gate

was not open to traffic (Newell 1994). Another traffic study indicated that SR 24 between the I-95 interchange and the Edgewood Area Main Gate received a Class E Level of Service rating during morning and evening peak periods, which is characterized as unstable traffic flow and major backups. A Class E rating suggests traffic volume between 91% and 100% of capacity (Henry 1994).

The road system within APG consists of more than 3 million square meters (about 3.6 million square yards) of paved and unpaved roads. The major routes on APG are designed to accommodate 9,000 vehicles per day, with trucks comprising 8 to 10% of the vehicles (USAMRDC 1992). Traffic flows well in the vicinity of USAMRICD and ECBC facilities (ECBC 2001d, USAMRICD 2001b).

4.2.8.2 Railroads

Amtrak and the Maryland Rail Commuter (MARC) provide passenger rail service to APG and its surrounding area. MARC provides scheduled commuter trains daily to Baltimore and Washington, D.C. Amtrak provides four trains daily to Washington, D.C., and New York City and has a terminal in the Town of Aberdeen. The northern boundary of the Edgewood Area is parallel to the Amtrak line (USAMRDC 1992, DA 1992).

Freight service in the APG area is provided by the Baltimore and Ohio and Norfolk Southern railroads. Norfolk Southern lines share the corridor with Amtrak and have interchange access to the approximately 48 kilometers (30 miles) of rail tracks on the Edgewood and Aberdeen Areas of APG (USACOE 2000a). Norfolk Southern's main line at Aberdeen interchanges with APG's rail system. APG personnel perform all rail activities within APG after transfer from commercial rail systems (USAMRDC 1992).

4.2.8.3 Airports and Airspace

Commercial airline service is available from Baltimore-Washington International Airport (BWI) in Baltimore, Maryland; Reagan National Airport (DCA) and Dulles International Airport (IAD) in the Washington, D.C., metropolitan area; and Philadelphia International Airport (PHL) in Philadelphia, Pennsylvania. The Edgewood Area is approximately 55 kilometers (34 miles) from BWI, 98 kilometers (61 miles) from DCA, 138 kilometers (86 miles) from IAD, and 121 kilometers (75 miles) from PHL (BWI Airport 2001).

Two airfields are located on APG: Phillips Army Airfield (PAA) in the Aberdeen Area and the WAH in the Edgewood Area. PAA is used by helicopters and fixed-wing aircraft, and WAH is used exclusively for helicopters. The Maryland Army National Guard operates WAH, which has one 1,524-meter (5,000-foot) runway (USACOE 2000a). The USAMRICD and ECBC facilities are immediately to the east of WAH. The airspace over PAA in the Aberdeen Area of APG is restricted (USAMRDC 1992).

4.2.8.4 Marine Transportation

Marine access to the Edgewood Area from the Chesapeake Bay is via piers on Lauderick Creek and Bush Creek northwest of Tapler Point (USACOE 2000a).

4.2.9 Utilities

Information on utility usage by ECBC and USAMRICD appears in Sections 2.4.1.2.a and 2.4.2.2.a, respectively.

4.2.9.1 Water Supply

The Van Bibber Water Treatment Plant (WTP) has supplied potable water to the Edgewood Area since its establishment during WWI. The Edgewood Area of APG is located about 3.2 kilometers (2 miles) south of the WTP. Surface water from Winter's Run, within the Bush River area freshwater subbasin (see Section 4.2.10), is the source of water supply. In times of drought, the Edgewood Area draws its water supply from the Harford County WTP, which uses the Susquehanna River as its water source. The Harford County WTP is located in Abington, Maryland, about 4.8 kilometers (3 miles) north of the Edgewood Area (Gentry 2002).

The Van Bibber WTP has a design capacity of approximately 15 million liters (4 million gallons) per day, with storage for about 4.9 million liters (1.3 million gallons) (USACOE 2000a). Surface water from Winter's Run is treated with alum and lime and disinfected by chlorination. The treated water is then injected with sodium silicate to reduce corrosion in the distribution system and transported via underground aqueduct to the Edgewood Area, where it is distributed to various buildings through a cast iron piping system (USAMRDC 1992, USACOE 2000a). The *2000 Annual Consumer Report on the Quality of Tap Water, Edgewood Area* indicated that no contaminants were detected in concentrations exceeding regulatory limits established under the Safe Drinking Water Act (USAG APG 2002).

4.2.9.2 Energy

Baltimore Gas and Electric (BGE) supplies the Edgewood Area of APG with electrical power transmitted from BGE's Perryman Island Power Plant through the Edgewood Area's Magnolia substation (USACOE 2000a). Commercial contractors supply gasoline, diesel fuel, and heating oil for the Edgewood Area of APG (Baldwin 2002).

Although a BGE natural gas main runs through Harford County within the I-95, USR 40, and Maryland SR 7 corridors (USAMRDC 1992), the Edgewood Area does not receive natural gas service (USACOE 2000a). The central heating system at the Edgewood Area, which uses steam purchased from the Harford County WEP (see Sections 2.4.1.2.a and 2.4.2.2.a), offsets fuel oil that APG would otherwise have to burn for heating purposes (Poulton 2002).

4.2.10 Water Resources

4.2.10.1 Surface Water

The boundaries of APG include the northern part of the Chesapeake Bay, which has a surface area of approximately 11,396 square kilometers (4,400 square miles). The Chesapeake Bay watershed comprises about 165,759 square kilometers (64,000 square miles), including portions of Delaware, the District of Columbia, Maryland, New York, Pennsylvania, Virginia, and West Virginia. The Chesapeake Bay has water quality problems associated with excessive inputs of organic matter, nutrients, and toxic substances that occurred mostly through the 1970s. Approximately two-thirds of the Bay is less than 5.5 meters (18 feet) deep, and tidal fluctuation

generally ranges between about 0.3 to 0.6 meters (1 to 2 feet). The net flow direction of tidal currents in the Chesapeake Bay is toward the ocean. Dense, saline water flows on the bottom of the Bay as lighter, lower-salinity water from the freshwater tributaries moves to the sea (USAMRDC 1992).

All surface waters of the State of Maryland shall be protected for Use I, Water Contact Recreation, Fishing, and Protection of Aquatic Life and Wildlife (Code of Maryland Regulation [COMAR] 26.08.02.07). This water use designation includes waters that are suitable for water contact sports; play and leisure time activities where individuals may come in direct contact with the surface water; fishing; the growth and propagation of fish (other than trout), other aquatic life, and wildlife; agricultural water supply; and industrial water supply. The waters of the Chesapeake Bay from the mouth of the Susquehanna River to the Virginia State Line have been classified as Use II Waters or Shell Fish Harvesting Waters (COMAR 26.08.02.08) by the State of Maryland. This area encompasses the tidal waters of the Chesapeake Bay bounded generally by the shoreline of the Bay and by "zero river mile" lines of estuaries and tributaries to the Bay as designated by MDE, and any peripheral waters designated as part of the Chesapeake Bay Proper by MDE after consultation with the Tidewater Administration and the USFWS. The water use designation includes waters where shellfish are propagated, stored, or gathered for marketing purposes and actual or potential areas for the harvesting of oysters, softshell clams, hardshell clams, and brackish water clams (Office of the Secretary of State Division of State Documents 2002).

Winter's Run at the Van Bibber WTP has a Use I-P watershed designation, which applies for water used for contact recreation, aquatic life, and public water supply. Discharges to Winter's Run must comply with the water quality criteria found in Code of Maryland Regulations (COMAR) Title 26 (USACOE 2000a).

The Edgewood Area of APG is located on the Gunpowder Neck peninsula adjacent to the upper reach of the Chesapeake Bay. Gunpowder Neck is bounded to the west by the Gunpowder River, to the east by Bush River, and to the south by the Chesapeake Bay. Surface runoff drains toward these surface water bodies or into smaller creeks that discharge into one of them. The smaller creeks draining the Edgewood Area include Canal Creek, King's Creek, Lauderick Creek, Swaderick Creek, Cooper's Creek, Watson Creek, Boone Creek, Wright Creek, Monk's Creek, and Reardon Inlet (USGS 1985). Canal Creek has the largest drainage system in the Edgewood Area, with a surface area consisting of approximately 1,214 hectares (3,000 acres) (USAMRDC 1992). Canal Creek drains into Gunpowder River. Reardon Inlet, Swaderick Creek, Watson Creek, and Wright Creek also drain into Gunpowder River. Lauderick Creek, King's Creek, Monk's Creek, Cooper's Creek, and Boone Creek discharge into Bush River (USGS 1985). The Gunpowder River and Bush River watersheds are the two major watersheds in the Gunpowder Neck peninsula. A third watershed, the APG Watershed, located on the southern tip of the Gunpowder Neck peninsula, comprises a majority of the Aberdeen Area of APG. The USAMRICD and ECBC facilities lie within the Bush River Watershed (MDE Surf Your Watershed 2001).

The low relief in the Gunpowder Neck peninsula and tidal effects created by the hydraulic connection with respect to the Chesapeake Bay create sluggish and shallow creeks and rivers.

Most of the land surface within APG lies within the 100-year floodplain as a result of the generally flat topography. A USACOE study conducted in 1983 characterized floodplains as land with elevations less than approximately 2.4 meters (8 feet) AMSL (USAMRDC 1992). The Edgewood Area has 71 sites that are subject to flooding within the 100-year flood zone, and 78 sites, including those in the former group, are subject to flooding within the 500-year flood zone (USACOE 2000a). The ECBC and USAMRICD buildings with the lowest elevations both lie at approximately 3 meters (10 feet) AMSL (USAMRDC 1992, USGS 1985).

The estuaries and creeks of APG may experience variations in salinity due to the freshwater contributions from the Susquehanna River, and to a lesser extent, smaller rivers and creeks, and due to the saline waters brought in by the tidal action (USACOE 2000a). The estuarine waters at APG range from tidal freshwater to low mesohaline, with salt content between 5 and 18 parts per thousand (Swihart et al. 1994).

Since 1919, the surface waters of APG have been used for test firing of projectiles. Several firing ranges share a portion of the Bush River (USAMRDC 1992). It is estimated that the surrounding waters of APG contain 4 million live rounds and 16 million inert rounds (Rosenblatt 1996). Other major sources of surface water contamination originating from APG include contaminants from historic solid and liquid waste disposal at APG; sanitary, industrial, and laboratory wastewater; and storm-water runoff/erosion and sedimentation (USACOE 2000a).

Surface water contamination at APG has been evaluated in the Gunpowder River basin and estuary, Lower Gunpowder Neck peninsula, Canal Creek, Watson Creek, Reardon Inlet, Bush River basin and estuary, Lauderick and Monk's Creeks, and King's Creek (USACOE 2000a). For the purpose of this PEIS, only Canal Creek and the Bush River basin and its tributaries (King's Creek, Lauderick Creek, and Monk's Creek) will be discussed, since the USAMRICD and ECBC facilities fall within the Canal Creek Study Area within the Bush River basin.

4.2.10.1.a Canal Creek

Most of the USAMRICD and ECBC facilities lie within the Canal Creek Study Area, in the northern portion of the Gunpowder Neck peninsula. Analyses of surface water samples collected from Canal Creek in the late 1980s indicated that nine metallic constituents (beryllium, cadmium, copper, iron, lead, mercury, silver, thallium, and zinc) exceeded the water quality criteria. These constituents are attributed to municipal and industrial waste discharges, discharge of contaminated groundwater, contaminated soil transported by storm-water runoff, and atmospheric deposition (Lorah and Clark 1992).

4.2.10.1.b Bush River Basin and Estuary

Some of the ECBC and USAMRICD facilities are located in the portion of the Edgewood Area that is drained by Bush River. The Bush River estuary is characterized as having fair water quality, due to elevated nutrient levels (Huber 1993). Although there is little data on organic chemicals and heavy-metal concentrations in Bush River estuary water, chemical levels in fish and shellfish there did not exceed the U.S. Food and Drug Administration recommended levels for metals and pesticides that concentrate in the fat of fish (MDE 1994).

Smaller creeks discharging into Bush River that have known or potential contamination problems include Lauderick Creek, Monk's Creek, and King's Creek.

4.2.10.1.c Lauderick Creek and Monk's Creek

Lauderick Creek and Monk's Creek both drain eastward into the Bush River. Monk's Creek is located in the extreme northeast portion of the Edgewood Area. The mouth of Lauderick Creek is approximately 2.1 kilometers (1.3 miles) south of the mouth of Monk's Creek. Both of these creeks may have been affected by past Nike Site operations. One surface water sample collected from Monk's Creek was analyzed for VOCs, which were not detected (DA 1993). Potential chemicals of concern for the creeks include chlorinated solvents, chemical agent decontamination products, chemical agent materiel, and unexploded ordnance (UXO) (DSHE 1994).

4.2.10.1.d King's Creek

King's Creek discharges eastward into the Bush River, and it lies approximately 0.8 kilometers (0.5 miles) south of Lauderick Creek. It is the closest water body to the USAMRICD and ECBC facilities, which are located approximately 152 meters (500 feet) from the smallest extension of King's Creek. During and after WWII, chemical and storm sewers from the hospital and chemical research laboratory complex located in the area currently occupied by USAMRICD discharged to ditches and the marsh associated with King's Creek. The chemical sewers were eliminated by the mid-1970s. Elevated concentrations of metals have been identified in the sediments of King's Creek. Although the precise source of these metals is unknown, it is believed that they originated from other research laboratories to the south and southeast of the USAMRICD facility complex (U.S. Army Environmental Hygiene Agency (USAEHA) 1989).

Other contaminants of concern in King's Creek include 11 inorganic constituents (beryllium, cadmium, copper, cyanide, iron, lead, mercury, nickel, silver, thallium, and zinc) in surface water samples that exceeded the relevant water quality criteria standards. These exceedances are thought to have originated from mobilization of accumulated metals in contaminated stream bottom sediments (Lorah and Clark 1992). King's Creek surface water also contains organic contaminants, primarily VOCs, at concentrations below their respective toxicity criteria. VOCs in surface water are attributed to contaminated groundwater discharge, current wastewater discharge, and dissolution of dense nonaqueous-phase liquids present in bottom sediment (Lorah and Clark 1992).

4.2.10.2 Groundwater

The general flow of groundwater in Harford County is from the elevated Piedmont Plateau Physiographic Province to the lower-lying Coastal Plain Physiographic Province (Trapp and Horn 1997). Groundwater in the vicinity of APG flows to the southeast toward the Chesapeake Bay (USACOE 2000a).

The Edgewood Area has a shallow water table that is frequently within 0.5 to 1 meter (approximately 1.6 to 3.3 feet) below the soil surface. The maximum depth to which the water table may be found is 10 meters (32.8 feet). Numerous shallow ponds occur where the water table is at the soil surface. The groundwater gradient is essentially low. Groundwater flow

within the subsurface usually ranges between 0.2 to 2 meters (approximately 0.7 to 6.6 feet) per year. Groundwater sources originate from the recharge of precipitation or infiltration of surface water sources.

Groundwater and the hydrogeologic setting under APG have been evaluated since 1917. More than 100 wells have been installed at depths generally ranging from 9 to 116 meters (30 to 381 feet) and yielding between 19 to 1,893 liters (5 to 500 gallons) per minute. Large quantities of groundwater are not present in the shallow aquifer underlying the USAMRICD and ECBC facilities (USAEHA 1989, USAMRDC 1992, ECBC 2001d).

The Potomac Group and the Pleistocene Age deposits comprise the underlying geology at APG. The Potomac Group consists of the Patuxent Formation, the Arundel Clay, and the Patapsco Formation. The Patuxent Formation is an important water-bearing formation in the Atlantic Coastal Plain that yields up to 16,466 liters (4,350 gallons) per minute near Perryman, Maryland (Nutter and Smigaj 1975), and 3,785 liters (1,000 gallons) per minute near Baltimore, Maryland (Bennett and Meyer 1952). It is often in direct contact with the Chesapeake Bay, which increases the potential for the intrusion of brackish water (USACOE 2000a). The Arundel Clay is considered an aquiclude, although small quantities of water may be realized from dug wells. The Patapsco Formation yields about 114 to 454 liters (30 to 120 gallons) per minute in Cecil County and about 3,028 liters (800 gallons) per minute at Sparrows Point near Baltimore (Advanced Sciences, Inc. 1990). Pleistocene deposits are widely used as water supply aquifers within the Coastal Plain. They are highly productive, with typical yields ranging from about 38 to 189 liters (10 to 50 gallons) per minute. Groundwater yields of 1,363 liters (360 gallons) per minute may be produced from the Pleistocene deposits within the Aberdeen Area of APG (Advanced Sciences, Inc. 1990).

The Pleistocene deposits and Potomac Group formations have been used or are used as water supply sources at APG. However, drinking water consumption of the groundwater in the Edgewater Area has been discontinued since the presence of chlorinated VOCs was verified in samples collected from 6 wells in 1984. There are no potable wells located on APG; however, there are 10 City of Aberdeen wells and 8 Harford County wells located within 4.8 kilometers (3 miles) of APG boundaries (USACOE 2000a).

The geological characteristics and contamination from anthropogenic activities generally determine the quality of groundwater. Groundwater quality in the vicinity of APG is related to well depth. Poor water quality is common in shallow wells, which naturally contain higher concentrations of iron, manganese, and sulfides and are subject to man-made contamination. Groundwater in deeper wells has better water quality with little contamination (U.S. Army Toxic and Hazard Materials Agency 1983). In areas of APG formerly used for the production and disposal of chemical compounds, groundwater from the wells frequently has concentrations of inorganic and organic substances exceeding the EPA Safe Drinking Water Standards (USAMRDC 1992).

Laboratory and industrial activities have adversely affected groundwater quality at APG. These activities involve materials such as UXO, chemical agents, and depleted uranium. Ammunition and propellant components have been released from laboratory and industrial testing, training,

open burning, and open detonation. The breakdown of UXO containing high explosives, chemical agents, and depleted uranium at the test ranges may contaminate the ground via absorption or adsorption (USACOE 2000a). Approximately 4,047 hectares (10,000 acres) in the Edgewood Area contain UXO. The components of UXO may impact groundwater quality by dissolution of the explosive propellant or interactions with groundwater and the UXO liquid agent. Evaluations of potential contaminants using modeling procedures have indicated that significant impacts on groundwater quality occur with the presence of trinitrotoluene. Depleted uranium has the potential to negatively impact groundwater quality in the immediate vicinity of the projectile; however, it would migrate very slowly (USACOE 2000a).

Seven land areas on the Gunpowder Neck peninsula of APG were evaluated for groundwater contamination by inorganic chemicals and VOCs (see Sections 4.2.4.3 and 4.2.10.1). Three of the study areas, Canal Creek, Bush River, and Lauderick Creek, are located in the vicinity of the major ECBC and USAMRICD facilities (USACOE 2000a).

4.2.10.2.a Canal Creek Study Area

Most USAMRICD and ECBC facilities lie within the Canal Creek Study Area, which is located in the northern portion of the Gunpowder Neck peninsula. This area has experienced direct discharge of untreated liquid waste to the east and west branches of Canal Creek from operations between 1918 through the 1970s (Lorah and Clark 1992). Contaminant plumes exist in the surficial aquifer and the Canal Creek aquifer. The maximum contaminant level (MCL) and secondary MCL were exceeded for several VOCs (carbon tetrachloride and trichloroethylene) and metals (aluminum, cadmium, iron, and manganese) (USACOE 2000a).

4.2.10.2.b Bush River Study Area

The Bush River Study Area consists of about 160 hectares (396 acres) of land located within the Edgewood Area on the small peninsula between King's Creek and Lauderick Creek and adjacent to Bush River. This area has been exposed to the disposal, handling, storage, and maintenance of lethal, riot-control, and incapacitating agents and other miscellaneous chemical materials since 1931. Radioactive waste was also handled at a dedicated facility in this area during the 1950s. Several areas may have possible contamination, including drum disposal areas, incinerators, landfills, munitions disposal pits, open burning pits, septic tanks, and underground storage tanks (DSHE 1993). Ten monitoring wells have been installed within this study area to identify the potential chemicals of concern, which include: organic and chlorinated solvents, heavy metals, explosive chemicals, radioactive waste, chemical agent materials, PCBs, and pesticides (USACOE 2000a).

4.2.10.2.c Lauderick Creek Study Area

The Lauderick Creek Study Area consists of approximately 507 hectares (1,254 acres) encompassing the entire area east of the Edgewood Gate and bounded by the installation perimeter on the north, Lauderick Creek on the south and west, and Bush River on the south and east (DSHE 1994). The study area also included the Nike Site located adjacent to the northern installation boundary, which was used for storage and maintenance of missiles from 1954 to 1973. Groundwater sampling from 23 wells in the Nike Site has indicated detectable concentrations of several chemicals of concern, including radioactivity (gross alpha, gross beta,

^{40}potassium, and ^{226}radium); VOCs (acetone, carbon disulfide, trans-1, 2-dichloroethylene, methylene chloride, trichloroethylene, and 2-ethyl-1-hexanol); semivolatile organic chemicals (bis 2-ethylhexyl phthalate); and metals (barium) (USACOE 2000a).

4.2.10.3 Wetlands

Swamps and tidal marshes at APG are considered to be wetland habitats. Marshes and swamps are characterized as open, shallow wetlands that contain numerous species of annual and perennial herbaceous plants. In general, wetlands develop in periodically or continually flooded areas and contain soils of diverse chemical and physical characteristics. These conditions suit a wide variety of plant communities. Wetlands provide breeding grounds for some fish and waterfowl species and provide food and shelter for ducks, geese, herons, shore birds, muskrat, mink, and beaver. Wetlands also help prevent excessive nutrients from being transported downgradient to surface water bodies and help to control floods.

Wetlands at APG are characterized as emergent wetlands (marshes) comprising about 3,130 hectares (7,735 acres); forested wetlands (swamps) comprising about 2,161 hectares (5,339 acres), mostly in the Aberdeen Area; and scrub-shrub wetlands (swamps) comprising about 87 hectares (214 acres). All three types of wetlands at APG include both tidal and nontidal portions. Tidal emergent wetlands are irregularly flooded by high spring tides and storms and dominated by persistent vegetation, while nontidal emergent wetlands are wet meadows and forb-dominated herbaceous areas in ponds, streams, and marshes. Emergent wetlands drain into low-salinity estuaries and freshwater creeks, are periodically flooded or waterlogged, and contain a variety of herbaceous plants. Extensive areas of emergent wetlands exist on tidal areas of Wright Creek, Watson Creek, Cooper's Creek, Lege's Point, Ford's Point, Robin's Point, and Rickett's Point on the Gunpowder Neck peninsula (USACOE 2000a).

There are about 1,062 hectares (2,625 acres) of wetlands in the Edgewood Area of APG (USACOE 2000a). The predominant marshes in the Edgewood Area consist of coastal, freshwater marshes, which are affected by tidal action (CRDEC 1988). Two USAMRICD buildings are within approximately 152 meters (500 feet) and two ECBC buildings are within approximately 76 meters (250 feet) of the edges of their respective closest wetlands (USAMRDC 1992). Numerous other wetlands are present within several miles of the ECBC and USAMRICD facilities (USFWS 1982).

4.3 Existing Environmental Attributes at the Naval Surface Warfare Center Dahlgren Laboratory

The Naval Surface Warfare Center Dahlgren Laboratory (NSWCDL) is located in King George County, Virginia. It is approximately 37 kilometers (23 miles) east of Fredericksburg, Virginia; 89 kilometers (55 miles south) of Washington, D.C.; and 105 kilometers (65 miles) northeast of Richmond, Virginia, as marked on the location map, **Figure 4-2**. The installation encompasses about 1,748 hectares (4,320 acres) in the Northern Neck area of northeastern Virginia along the Potomac River. Upper Machodoc Creek divides NSWCDL into two areas, Mainside, comprising about 1,084 hectares (2,678 acres), to the north and Pumpkin Neck, comprising about 664 hectares (1,641 acres), to the south (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

Figure 4-2. Location of the Naval Surface Warfare Center Dahlgren Laboratory

The Chemical and Biological Defensive Warfare Laboratory (CBL) Building is located in the extreme northeastern portion of Mainside in the Advanced Concepts Complex area of the installation.

4.3.1 Air Quality

The NSWCDL is located within a pleasant, relatively mild, four-season climate. Summer days are hot and humid, and winters are usually mild with moderate snowfall. Relative humidity is generally high due to the influence of the Atlantic Ocean. The average maximum temperature is about 19.3°C (66.7°F), with daily maximum temperatures ranging from about 7°C to 31°C (45°F to 87°F). The average minimum temperature is 9.4°C (48.9°F), with daily minimum temperatures ranging from about -1.6°C to 20.5°C (29°F to 69°F). The average annual precipitation for the NSWCDL area is about 100 centimeters (39.4 inches), which is distributed uniformly throughout the year, with slight increases in July and August (World Climate 2000). In late summer and early fall, this area is at risk for high-precipitation events due to hurricanes. The average annual snowfall is 37 centimeters (14.6 inches). The average annual wind speed is 12.2 kilometers (7.6 miles) per hour (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

King George County is in attainment with all applicable ambient air quality standards (U.S. EPA 2001a).

Annual emissions of criteria pollutants from NSWCDL for 1999 included 8.96 metric tons (9.88 tons) of CO, 74.28 metric tons (81.90 tons) of NO_x, 1.87 metric tons (2.06 tons) of PM_{10}, 16.56 metric tons (18.26 tons) of SO_2, and 1.44 metric tons (1.58 tons) of VOCs. Pollutants attributed to CBDP activities are estimated at 2% of the above figures. Relative to total emissions for King George County, the NSWCDL accounted for 0.95 percent of CO emissions, 17.92 percent of NO_x emissions, 3.42 percent of PM_{10} emissions, 4.35 percent of SO_2 emissions, and 3.04 percent of VOC emissions (U.S. EPA National Emissions Inventory 2003).

4.3.2 Biological Resources

NSWCDL has prepared an INRMP, which describes the natural resources at the installation, in accordance with the Sikes Act Improvement Act of 1997 (16 USC 670 *et seq.*) and DoD Directive 4700.4, Natural *Resources Management Programs,* which require military installations to prepare INRMPs.

4.3.2.1 Terrestrial Resources

Terrestrial habitats (uplands) make up 84% of the NSWCDL, and approximately half of the uplands is forested, including oak-hickory forest (28%), loblolly pine forest (15%), and loblolly pine-hardwood forests (8%). Mainside, especially the north end, is forested with pine species primarily to the east, mixed pine-hardwood species in the center, and hardwood species to the west. The southern end of Mainside, which has the majority of building development, is covered with grass, scattered mature trees, and street tree plantings. The NSWCDL supports more than 300 species of plants representing 86 families. No federally protected rare plant species have been found at NSWCDL; however, the threatened small whorled pogonia may possibly exist on the installation (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). The CBL Building is located in the semideveloped area of the northeast corner of Mainside. Only grassy areas, landscaped areas, and trees planted along roads are present within the vicinity of the CBL Building.

The productive forest communities at NSWCDL support a diversity of common wildlife, including deer, skunk, raccoons, and woodchucks. It is estimated that 157 avian, 20 mammalian, 16 amphibian, and 16 reptilian species are found at NSWCDL (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). The area surrounding the CBL Building is used by the common wildlife. Mammals (rabbits, squirrels, etc.), birds of prey (osprey, hawks, etc.), wading birds (great blue heron, great egret, etc.), waterfowl (swans, geese, ducks, etc.), songbirds (cardinal, bluejay, robin, etc.), and game birds (wild turkey, etc.) are all characteristic of the area (Martens 2000).

4.3.2.2 Aquatic Resources

Approximately 10% of the installation is tidal wetlands (estuarine systems) and 6% is nontidal, freshwater wetlands. The tidal wetlands are ecologically important areas that provide adult, migratory, spawning, and nursery habitat for fish populations. Anadromous species such as striped bass, American shad, blueback herring, alewife, and white perch use the Potomac River

to reach the wetlands associated with Upper Machodoc Creek and Gambo Creek to spawn and provide nursery habitats (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

Recent fish sampling from NSWCDL and the Alliance for the Chesapeake Bay collected 24 species of fish. The most abundant species included Atlantic menhaden, Atlantic silverside, banded killfish, bay anchovy, mummichog, and white perch. Significant populations of bluecrab and American oyster were also found (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

Thirty-two species of freshwater fish have been identified in Gambo Creek, Black Marsh, Hideaway Pond, and Cooling Pond. Some of the commonly occurring fish found were largemouth bass, bluegill, black crappie, and channel catfish (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). The CBL Building is located about 122 meters (400 feet) from the nearest aquatic habitat.

4.3.2.3 Critical Habitats and Species of Special Concern

The Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-NH) conducted a Natural Heritage Inventory at NSWCDL during 1991 and 1992. The only federally-listed threatened species known to occur at NSWCDL is the bald eagle (*Haliaeetus leucocephalus*). During the 2000-2001 nesting season, there were three active nest sites on Pumpkin Neck and one on Mainside (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). There is one state-listed rare species at NSWCDL. The funnel-web spider (*Agelenopsis kastoni*) is listed as very rare and imperiled, with 6 to 20 occurrences—few remaining individuals—in Virginia. This species was found during surveys conducted in 1991/1992 in a wooded area over a mile away from the CBDP facilities. Additional rare species that could possibly exist at NSWCDL are the small whorled pogonia, sensitive joint vetch, and dwarf wedge mussel. Species that were once on the state rare-species list but have been removed occur at NSWCDL, including two species of dragonfly, a damselfly, a spider, and a beetle (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001, Virginia Department of Conservation and Recreation 2001).

The DCR-NH has identified five Special Interest Areas (SIAs) at NSWCDL for species habitat and watershed protection. The approximately 68-hectare (167-acre) Forested Wetland Swale, in the northwestern portion of Mainside, is characterized as an extensive forested wetland occupied by previously state-listed rare species of invertebrates and the state-listed rare funnel-web spider. The Gambo Creek Protection Area is located to the south of USR 301 and continues to the west along Gambo Creek (NSWCDL 2001a). This 260-hectare (643-acre) SIA consists of a brackish-intertidal emergent marsh community dominated by saltmarsh cordgrass, marsh elder, and pigweed and buffered by mixed hardwood and pine forests. It provides nesting areas for bald eagles and suitable habitats for other birds, fish, and uncommon invertebrates (NSWCDL 2001a). The other three SIAs, which are located on Pumpkin Neck (Tetotum Flats North, Tetotum Flats South, and Tetotum Flats East), comprise a total of about 90 hectares (223 acres). These are protected areas due to the occurrences of active bald eagle nests (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

The CBL Building is not located within the boundaries of an SIA, and the site does not contain any known endangered, threatened, or unique flora or fauna (Martens 2000). The Advanced Concepts Complex is partially included in the Gambo Creek Protection Area.

4.3.3 Cultural Resources

NSWCDL has a rich historical past. Due to the location along the Potomac River and its tidal tributaries, it is thought that trading between Indians and early European settlers took place within or near the installation. NSWCDL also has historically significant sites relating to the Civil War and significant periods from the 18th through the 20th centuries (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

4.3.3.1 Historical Sites

Four historic districts were identified in a study of standing structures with the operational and industrial areas on Mainside, as follows: (1) the Main Battery, including primarily major-caliber gun emplacements; (2) the Wharf Area, a historical docking area along Upper Machodoc Creek linking it to the Main Battery; (3) the Airfield, including the airstrip and associated aircraft facilities; and (4) the Residential District, which contains most of the historical houses. Structures in these districts represent early Dutch colonial architecture mixed with more recent styles. The first three historic districts include buildings and associated landscape features that are representative of NSWCDL's historical weapons testing and research operations. All four historic districts are located at least 2.7 kilometers (1.7 miles) from the CBL Building (NRHP 2001; NSWCDL 2001b; Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

4.3.3.2 Archaeological Sites

Two areas identified as terrestrial archaeological sites are located within close proximity—106 meters (350 feet)—to the CBL Building: the Payne North Site and an unnamed small archaeological site.

The Payne North Site was registered with the Virginia Department of Historic Resources as Site 44KG170. This site, which was surveyed during Phase I and II archaeological studies between 1994 and 1998, contains a large shell midden that was radiocarbon-dated back to before 400 B.C. Some of Virginia's oldest aboriginal ceramics have been discovered here, as well as some of the earliest indications of long-term aboriginal occupations. The Phase II investigations indicated that the Payne North Site is important, warrants protection and further investigation, and meets the criteria for nomination to the NRHP.

The unnamed small archaeological site was identified in a 1994 survey. A Phase I analysis and subsequent evaluation dated it as late 19th or early 20th century. Protection of the site and further evaluation by a Phase II study were both recommended (Martens 2000).

4.3.4 Earth Resources

4.3.4.1 Topography

The topography of NSWCDL is characterized by low relief with gentle sloping. Land surface elevations at the installation range from 0 to 7.6 meters (0 to 25 feet) AMSL. Most of the area is

flat except along sections of the Potomac River and associated tributaries where there is moderate to steep sloping (NSWCDL 2001b, Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). The CBL Building is located at an elevation less than about 3 meters (10 feet) AMSL (Martens 2000).

4.3.4.2 Geology

NSWCDL is located within the Coastal Plain Physiographic Province, which is characterized as a lowland that borders the Atlantic Ocean. This province consists of semiconsolidated to unconsolidated sediments, including silt, clay, and sand, with some gravel and lignite. The sediments range in age from Cretaceous to Recent (Virginia Department of Mines, Minerals, and Energy 2001, USGS 2001a).

The geologic unit underlying NSWCDL is the Nanjemoy Formation, which dates from the early to late portion of the Eocene epoch of the Tertiary period. It is 45 meters (148 feet) thick and is composed of alternating quartz and glauconite sands, clays, and calcitic units of shell and cavernous shell limestone. The basal unit of the formation, the Marlboro Clay, is a 6.1- to 9.1-meter-thick (20- to 30-foot-thick) alternating pinkish-orange and dark gray clay (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

4.3.4.3 Soils

The Soil Conservation Service classified 28 soil types at NSWCDL. Most of these soils are classified as the Tetotum-Bladen-Bertie Soil Association, which consist of deep, moderately well drained, nearly level to sloping fine sandy loam and clay loam. They have a strongly acidic to very strongly acidic subsoil and are low in natural fertility and organic matter content. The Tetotum subsoil is moderately permeable with moderate moisture capacity. The Bladen Soil Series consist of deep, poorly drained, nearly level soils that formed in the loamy and clayey sediment in northern and northeastern King George County. Soils of the Bladen Series have very strongly acid subsoil, low in organic matter content and naturally infertile. They have slow permeability and moderate moisture capacity. The Bertie Soil Series consist of deep, somewhat poorly drained, nearly level to very gently sloping sandy and clay loam that formed in low areas. These soils are very strongly acidic, and low in organic matter content and natural fertility. Permeability is moderate and the moisture capacity is moderate to high in Bertie Soils (USDA-SCS 1974).

The Advanced Concepts Complex has 11 different soil types, but 2 of those cover about half the complex. Around the facilities, the soil types are generally fine sandy loams that have a moderate permeability (NSWCDL 2001b). Two types of soil underlie the CBL Building, the fine sandy loam Tetotum soil and the very fine sandy loam Bertie soil (Martens 2000).

4.3.4.4 Seismic Activity

Although Virginia is tectonically active, most of the earthquake activity occurs northwest of Richmond. There have been six earthquakes recorded northwest of Richmond from 1930 to the present. All six recorded magnitudes from 3.0 to 5.0 on the Richter scale. There have been no earthquakes reported in the King George County area (Environmental Systems Research Institute

2001). NSWCDL is located within Seismic Zone 1, which expects a low level of severe seismic activity (Martens 2000).

4.3.5 Land Use

Outside of the installation boundary of NSWCDL, there are residential and commercial properties to the west and north. The Potomac River forms the eastern boundary, and the Upper Machodoc Creek forms the southern boundary of NSWCDL Mainside. Pumpkin Neck is surrounded by water on three sides (Potomac River to the east and the Upper Machodoc Creek to the west and north), and agricultural land borders Pumpkin Neck to the south (NSWCDL 2001b).

NSWCDL has a total of 569 buildings covering over 19 hectares (47 acres), most of which are located on Mainside. Additional residential housing on the installation comprises 251 buildings. There is an airfield located on the southern portion of Mainside, which has over 2.4 hectares (6 acres) of paved land. NSWCDL has approximately 69 kilometers (43 miles) of road covering about 42 hectares (105 acres), including about 6.4 kilometers (4 miles) of residential roads.

There are six areas of building development at NSWCDL, three Research, Development, Test, and Evaluation (RDT&E) complexes (Advanced Concepts, Warfare Systems, and Weapons Development) and three support complexes (Industrial, Command Support, and Residential/Recreational). The three RDT&E complexes are large institutional-like facilities surrounded by large parking lots, comparable to suburban office parks. The Industrial Complex is mostly one-story maintenance and storage buildings, department shops used for weapons fabrication, and public works administration. The airfield mentioned previously is located in the middle of NSWCDL, adjacent to the RDT&E area. Most of the command support, administrative, and housing and recreational facilities are located to the southwest of the airfield (NSWCDL 2001b).

Direct testing of weapons occurs at six test ranges on Mainside, in the Weapons Complex, including a 32-kilometer (20-mile) segment of the Potomac River adjacent to and south of the installation, and two test ranges on Pumpkin Neck, which comprise approximately 71 hectares (175 acres). The test ranges consist of small support buildings, equipment and hardstand areas, and several test facilities. Mainside also has five magazine storage areas located in the center of NSWCDL.

The CBL Building is located in the Advanced Concepts Complex, in the northeast corner of NSWCDL. This area has three types of land use: the buildings that support RDT&E functions, undeveloped open space surrounding the buildings, and associated ranges to the south (NSWCDL 2001b).

CBDP activities at NSWCDL are conducted in accordance with the CMZA federal consistency requirement. In its *Record of Categorical Exclusion for the Construction, Installation, and Operation of the Chemical/Biological Research, Development, Test and Evaluation Laboratory at NSWCDL, Dahlgren, Virginia* (Martens 2000), the Navy certified that the 'action is consistent with the Virginia Coastal Zone Management Plan.' In the subsequent *Environmental Assessment, Laboratory Operational Upgrade at NSWCDL* (NSWCDL 2002), it was determined

that the proposed upgrading to BSL-3 "is not reasonably likely to impact the land or water uses or natural resources of the Commonwealth of Virginia's or Maryland's coastal zone."

4.3.6 Noise

The CBDP support operations at NSWCDL produce no discernable noise above ambient levels. Generally, the main source of intermittent noise on NSWCDL is from traffic on USR 301, which adjoins the installation's northern boundary for approximately 3.2 kilometers (2 miles). Ordnance and/or energetic material operations occasionally generate noise loud enough to result in inquiries or complaints from the public. For such operations, NSWCDL uses the Sound-Intensity Prediction System, a computer model, to keep noise intensities outside the installation boundaries at acceptable levels. However, these ordnance and energetic material operations are not associated with the CBDP work conducted at NSWCDL (Martens 2002).

4.3.7 Socioeconomics and Environmental Justice

4.3.7.1 Economic Activity

Labor statistics for 1999 for King George County indicate that federal, state, and local government agencies accounted for 46.1% of the total employment for King George County. In 1999, there were 6,067 private sector jobs, 3,746 federal civilian jobs, 927 federal military jobs, 679 state and local government jobs, and 186 agricultural sector jobs. This is especially striking when compared to the state statistics. Total government jobs in Virginia account for only 18.3% of the job force, while the private sector supplies 80.2% of the jobs in the state. Most private sector jobs are in service, retail trade, and manufacturing (U.S. Bureau of Economic Analysis 2000). As of November 2001, 1.6% of the labor force was unemployed in King George County (Virginia Employment Commission 2001).

NSWCDL plays an important role in the economy of King George County. As of 2002, full-time civilian government personnel supporting CBDP activities in the CBL Building comprise approximately 1.8% of the civilians employed at the installation (NSWCDL 2001c, Martens 2002a).

The importance of NSWCDL to the economy of King George County is also represented in the local earnings data. In 1999, total earnings for the County were $352,080,000 for the Federal Government; $193,753,000 for the private sector; $19,934,000 for state and local governments; and $581,000 for farming (U.S. Bureau of Economic Analysis 2000).

4.3.7.2 Income

Per capita personal income in 1999 for King George County residents ($26,769) was slightly lower than the national and state averages ($28,546 and $29,794, respectively). According to 1997 model-based estimates from the U.S. Census Bureau, the median household income in King George County was $45,575, and 9.2% of the people in King George County were below the poverty level (U.S. Census Bureau 2001).

4.3.7.3 Population and Demographics

The 2000 population of King George County was 16,803, consisting of 78% white, 19% black, 1.0% Asian, 0.5% Native American/Alaskan Native, and 0.1% Pacific Islander. Approximately 0.5% are listed as some other race and 1.6% as persons of two or more races. The Hispanic population, who may be listed as any race, accounted for 1.8% of the population. The population at Dahlgren Census Designated Places (CDPs) in 2000 was 997, consisting of 70% white, 25% black**,** 1.5% Asian, 0.3% Native American/Alaskan Native, and 0.1% Pacific Islander. Approximately 0.6% are listed as some other race and 1.9% as persons of two or more races. The Hispanic population constitutes 1.7% of the total for Dahlgren CDP (U.S. Census Bureau 2001).

4.3.7.4 Housing

In 2000, the average price for a new home in the Fredericksburg, Virginia, area, which includes King George County, was $151,509 (Koebel 2001). Housing for military personnel and dependents on NSWCDL includes 251 buildings (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). None of the military personnel living on NSWCDL are directly associated with CBDP activities.

4.3.8 Transportation and Airspace

4.3.8.1 Highways and Roads

The major highways in the vicinity of NSWCDL are USR 301 and I-95. USR 301 runs northeast-southwest and forms the northern boundary of the installation. It crosses the Potomac River heading northeast into Maryland and provides access to the Baltimore-Washington metropolitan area. I-95 runs north-south and passes through the City of Fredericksburg 37 kilometers (23 miles) west of the installation, providing access to the City of Richmond.

The main entrance gate at NSWCDL is directly off Virginia Route 206 (Dahlgren Road), which intersects with USR 301. USR 301 provides a secondary entrance to NSWCDL, called Gate B. There are several routes to NSWCDL from I-95. The Virginia Route 3 exit at Fredericksburg connects to Virginia Route 206, which leads east to the main gate. Access to NSWCDL from the south is gained by exiting I-95 at Virginia Route 207, heading northeast and connecting with USR 301, which leads north to the secondary entrance (NSWCDL 2001d).

Entrances through the gates are allowed through security checkpoints. NSWCDL has approximately 69 kilometers (43 miles) of road covering about 42 hectares (105 acres), including 6.4 kilometers (4 miles) of residential roads (NSWCDL 2001b).

Other ground transportation located in the vicinity of NSWCDL includes the Greyhound and Lee Coaches bus companies, which have stations in Fredericksburg (NSWCDL 2001c).

4.3.8.2 Railroads

There is an Amtrak station at Fredericksburg, Virginia, approximately 48 kilometers (30 miles) west of NSWCDL (NSWCDL 2001c).

4.3.8.3 Airports and Airspace

Commercial airline service is available from BWI in Baltimore, Maryland; DCA and IAD in the Washington, D.C., metropolitan area; and Richmond International Airport (RIC) in Richmond, Virginia. NSWCDL is located approximately 125.2 kilometers (77.8 miles) south of BWI, 97.8 kilometers (60.8 miles) south of DCA, 133.1 kilometers (82.7 miles) south of IAD, and 121.5 kilometers (75.5 miles) north of RIC (Metropolitan Washington Airports Authority 2001, BWI Airport 2001).

The airfield at NSWCDL has one Class "A" active runway for small aircraft and two inactive runways. Dahlgren Air Operations provides flight services within an 805-kilometer (500-mile) radius of NSWCDL using contractor-operated aircraft that seat up to 12 passengers. The airfield is also used for visitors arriving and/or departing by helicopter. The runway can be used only in daylight hours in clear weather (AirNav 2001, NSWCDL 2001b).

4.3.8.4 Marine Transportation

Marine transportation is not available at NSWCDL.

4.3.9 Utilities

4.3.9.1 Water Supply

The average potable water usage at NSWCDL is 1,589,868 liters (420,000 gallons) per day, with peak consumption at 3,039,676 liters (803,000 gallons) per day. Potable water usage for CBDP activities is only about 1% of the installation total (NSWCDL 2001a).

4.3.9.2 Energy

NSWCDL purchases electricity from Virginia Dominion Power of Richmond, Virginia, averaging 11.5 megawatt-hours (mWh) per day, with peak usage of 16.8 mWh per day. Buildings conducting CBDP activities use approximately 1% of the installation's total power consumption. NSWCDL also has five large Mobile Utilities Support Equipment generators and a number of small electrical generators that can be used for high-demand days or for emergency backup power. One of the large generators provides emergency backup power for the CBL Building and other nearby buildings (Martens 2002a).

Fuel oil, mainly for heating buildings, is purchased from commercial local and out-of-state providers (see Section 2.3.4.2.a) (NSWCDL 2001a).

4.3.10 Water Resources

4.3.10.1 Surface Water

NSWCDL is located on the west bank of the Potomac River, in the Potomac River subbasin of the Potomac and Shenandoah River basin. The Potomac River flows northeasterly from headwaters in Highland County, Virginia, through West Virginia and Maryland before its convergence with the Shenandoah River. It continues along the border between Maryland and Virginia, flowing southeastward toward the Chesapeake Bay. The Potomac River adjacent to NSWCDL is approximately 2,743 meters (9,000 feet) wide. The Potomac River subbasin is

approximately 38,073 square kilometers (14,700 square miles) in area, with approximately 7,306 square kilometers (2,821 square miles) located in Virginia.

The Potomac River near NSWCDL is tidal and is classified as an estuary zone. Its salinity is classified as mesohaline (5 to 12 parts per thousand) in this area. The State of Maryland has jurisdiction over the Potomac River. The Maryland Water Pollution Control Regulations (COMAR 26.08) have designated the Potomac River as Class II (water suitable for shellfish harvesting). The water quality within the NSWCDL segment of the Potomac River meets Clean Water Act standards for water contact recreation, aquatic life, and shellfish harvesting.

NSWCDL is bisected by about 9.6 kilometers (6 miles) of Upper Machodoc Creek, which flows to the east into the Potomac River. The northern portion of the installation, Mainside, is drained by Gambo Creek, a tidal estuary, and several unnamed tributaries. Gambo Creek flows southeast into the Potomac River (National Oceanic and Atmospheric Administration (NOAA) 2001, Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). Other water bodies on Mainside include Hideaway Pond, to the southwest of the Advanced Concepts Complex, and the Cooling Pond, on the east side of the residential/recreational area. Runoff from the CBL Building and other Advanced Complex facilities discharges into either the Potomac River to the east or into Hideaway Pond (NSWCDL 2001b). There is a minimum 91-meter (300-foot) setback from the Potomac River shoreline at normal high tide (Martens 2000).

Under the Virginia Water Quality Standards (VR 680-21-00), Upper Machodoc Creek and its tributaries are designated Class IIa (estuarine waters capable of propagating shellfish). The remaining tributaries of the Potomac River within the installation are designated Class IIb (estuarine water with Potomac River embayment standards) (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001). The Virginia Department of Environmental Quality (DEQ) and the DCR assessed the overall water quality of the Potomac River subbasin based on the DEQ water quality standards for the designated uses of the waters for aquatic life, fish consumption, swimming, and public water supply (DEQ and DCR 2000).

4.3.10.2 Groundwater

The NSWCDL lies in the Northern Atlantic Coastal Plain aquifer system, which consists mostly of semiconsolidated sand aquifers separated by confining clay units. These aquifers are vertically stacked and hydraulically connected; therefore, the groundwater flow systems function in the same fashion, and a change in conditions in one of the aquifers affects the others. The withdrawal of groundwater from the Northern Atlantic Coastal Plain aquifer system amounts to 3,895 million liters (1,029 million gallons) per day. Nearly one-fourth of the Coastal Plain population depends on groundwater for supply (USGS 2001a).

The only productive aquifer in the vicinity of NSWCDL is the Potomac Group artesian aquifer, which is composed of three aquifers and three confining units that are collectively labeled the Potomac Formation. In the northwest area of King George County, this aquifer is located at depths of approximately 183 to 533 meters (600 to 1,750 feet). The deep wells of NSWCDL draw from the upper Potomac aquifer. The static water levels were determined to range from approximately 35 to 37 meters (116 to 123 feet) below surface level, with a combined yield of

approximately 1,325 liters (350 gallons) per minute (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

4.3.10.3 Wetlands

Approximately 273 hectares (675 acres) of wetlands (16% of the overall installation area) were identified and mapped at NSWCDL. The most extensive wetlands are located in the Gambo Creek tidal marsh area, which has 90 hectares (approximately 222 acres) of wetlands (Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001, NOAA 2001). Within about 610 meters (2,000 feet) of the CBL Building, there are six wetlands, each approximately 0.4 to 0.8 hectares (1 to 2 acres) in size (NSWCDL 2001b).

Approximately 283 hectares (700 acres) of NSWCDL (16% of the overall site) are located in the 100-year floodplain of the Potomac River, Upper Machodoc Creek, and Gambo Creek. A portion of the Advanced Complex is located within this floodplain, but the CBL Building is all well above it. Shore and wetland areas associated with these water bodies are protected under the Chesapeake Bay Preservation Act (Chesapeake Bay Local Assistance Board, Chapter 21). Development in these vicinities is regulated as a means to control the potential for flooding and to protect water quality by reducing storm-water runoff (Chesapeake Bay Preservation Act Sec. 10.1-2111, *Local government requirements for water quality protection*) (NSWCDL 2001b, Parsons Engineering Science, Inc., and Geo-Marine, Inc. 2001).

4.4 Existing Environmental Attributes at the U.S. Army Medical Research Institute of Infectious Diseases

The U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID) is located at Fort Detrick in Frederick County, Maryland, as marked on **Figure 4-3**, the location map. Fort Detrick consists of four separate parcels in the northwest portion of the City of Frederick, Frederick County, Maryland. The four parcels of land are identified as Areas A, B, and C (two parcels) and encompass a total of 498 hectares (1,230 acres). The main USAMRIID facilities are located in the central and southern portions of Area A, which has an area of approximately 326 hectares (805 acres) (USAG 1998).

Figure 4-3. Location of the U.S. Army Medical Research Institute of Infectious Diseases

4.4.1 Air Quality

The temperate continental climate in Frederick County is characterized with four distinct seasons including short, warm summers and mild winters with occasional cold periods. Local weather patterns are influenced by the north-south trending Catoctin Mountains, which are located approximately 8 kilometers (5 miles) west of Frederick (USACOE 1996). The City of Frederick has an average high temperature of 18.9°C (66ºF) and an average low temperature of 6.6°C (44ºF). The extreme temperatures recorded in Frederick were 42.8°C (109°F) in July and -29°C (-21°F) in January. The average annual precipitation is 102.6 centimeters (40.4 inches), and the average relative humidity is 65% (International Station Meteorological Climate Summary 2001). The average annual snowfall is 67.1 centimeters (26.4 inches) for Frederick County (Maryland State Office of Climatology 2001). Between 1950 and 2001, the following weather-related events occurred in Frederick County: 22 tornados, 31 floods, 24 hail events, 18 lightning events, 126 thunderstorms and high-wind events, and 10 droughts (National Climatic Data Center 2001).

The average wind speed in the City of Frederick is 11.9 kilometers (7.4 miles) per hour. Prevailing northwesterly winds occur from October to April. Prevailing southwesterly winds from May through September result from a large pressure system in the Atlantic Ocean, the Bermuda High, which brings warm, moist air to the Frederick County region (Maryland Office of Environmental Programs 1986).

The overall air quality of Frederick County, including Fort Detrick, is good, with the exception of O_3 (Gluth 2000, MDE ARMA 2001a). According to the EPA, Frederick County is located within a serious nonattainment area for ozone. This is attributed to industrial and vehicular emission of ozone precursors. A monitoring station located at the Frederick County Health Department, approximately 0.8 kilometers (0.5 miles) from Fort Detrick, recorded peak 8-hour O_3 concentrations exceeding the NAAQS criteria level of 85 parts per billion (ppb) for 20 days during the second and third quarters of 1999. The exceedances for O_3 began before 1999 and have continued through the second quarter of 2000. This station also recorded peak HAGLO levels exceeding the NAAQS criteria level of 125 ppb for more than 1 day in September 1998 and July 1999 (MDE ARMA 2001b). The other NAAQS criteria pollutants have been in attainment during this time (MDE 2002b).

The main stationary sources of air pollution at Fort Detrick consist of incinerators, boilers, and diesel generators. Commuter and on-site traffic constitute the mobile sources of air pollution at the installation. Fort Detrick is the third largest source of NO_x emissions in Frederick County according to MDE; most of those emissions originate from operation of the boiler and generator facilities. Landfills were identified as the primary sources of VOC emissions at the installation (USAG 1998).

Odors emanating from Fort Detrick have been attributed to the boiler plant, which generates steam for heating and processing purposes. The boiler burns natural gas as a primary fuel and heavy fuel oil (No. 6) as a backup fuel. Use of fuel oil increases from 20% during normal operations to as much as 40% when the price of natural gas is very high, which occurred in 1999 and 2000 (Greenwood 2001). Odors from the two medical waste incinerators, the two municipal waste incinerators, and the boiler plant have been observed at ground level occasionally when thermal inversions occur in the early morning hours. The third most significant source of odor complaints at Fort Detrick has been identified as autoclaving of research animal feed at the National Institutes of Health's National Cancer Institute (NCI)-Frederick, a major tenant of the installation. The NCI-Frederick emissions do not threaten human health, according to MDE (Greenwood 2001, Dasey 2002).

Other odor sources include certain routine operations conducted at the installation. Petroleum odors may be generated during transfer of fuel oil from the main delivery tank to smaller boiler plant tanks, which occurs up to six times per day. Garbage odors may arise during the transport of waste (Greenwood 2001). Odors also originate on occasion from the wastewater treatment plant in Area C. However, USAMRIID has not had complaints regarding odors associated with the CBDP-related activities (Dasey 2002).

4.4.2 Biological Resources

Biological resources at Fort Detrick are described in the installation's INRMP. The INRMP satisfies the statutory and regulatory mandates discussed in Section 4.1.2, as well as AR 200-3, *Environmental Quality Natural Resources-Land, Forest, and Wildlife Management* (USAG 2001). The INRMP for Fort Detrick lists the natural and introduced vegetative species, the bird species, and the mammal species at Fort Detrick in Appendices 1, 2, and 3, respectively (USAG 2001).

4.4.2.1 Terrestrial Resources

The native vegetation has been either destroyed or highly altered in the Frederick area due to urbanization. The predominant vegetative communities in Area A of Fort Detrick include grasslands, upland forest, and wetland/riparian areas. Approximately 202 hectares (500 acres) of pastures, forested areas, grasslands, and agricultural fields are currently managed at the installation. Large open fields consisting of alfalfa, tall fescue, and bromegrass occur on Area A. Three major forest blocks ranging in size from about 4.9 to 5.7 hectares (12 to 14 acres) and consisting of pine, spruce, scarlet oak, red oak, and Siberian elm trees are located on Area A. The closest block to USAMRIID facilities is approximately 183 meters (600 feet) distant (USAG 2001).

The forested areas of Fort Detrick provide shelter to birds, mammals, and reptiles common to the oak hickory and northern hardwood forest. The following bird species are commonly observed on the installation: yellow warblers, blue jays, house sparrows, field sparrows, American robins, and northern cardinals (USAG 1998). Commonly occurring mammals at Fort Detrick include the white-tailed deer, raccoon, opossum, gray squirrel, and fox squirrel. Deer and other wildlife are managed at Fort Detrick to control the size of the herds (USAG 2001).

4.4.2.2 Aquatic Resources

The Nallin Farm Pond is located on the extreme eastern portion of Area A. Nine species of freshwater fish occur in the pond, including largemouth bass, smallmouth bass, bluegill, pumpkinseed, green sunfish, rainbow trout, yellow bullhead, golden shiner, and carp (Swihart et al. 1994).

4.4.2.3 Critical Habitats and Species of Special Concern

COMAR 08.03.08 contains the official State of Maryland Threatened and Endangered Species List. There are no records of federal or state-listed rare, threatened, or endangered species of plants or animals occurring on Fort Detrick (Slattery 1997).

4.4.3 Cultural Resources

Fort Detrick maintains a Historic Preservation Plan developed in conjunction with the Maryland Historical Trust. This plan classifies select structures and sites on the installation according to potential historic significance and identifies appropriate treatments and maintenance requirements for preservation. The installation also maintains a Cultural Resource Management Plan (CRMP), as required by AR 200-4, *Cultural Resources Management* (USACOE 1992).

Area A of Fort Detrick is located on the site of Detrick Field, a 36.4-hectare (90-acre) municipal airfield named for Major Frederick Lewis Detrick, a Frederick native and WWI veteran. The airfield was opened by Frederick County in 1929, leased to the Maryland National Guard in 1931 for use as a summer training camp, and leased to the Army Air Corps in 1940 for use as a training facility for military pilots. In 1943, the City of Frederick sold Detrick Field to the Army Chemical Warfare Service for use in research and development of biological warfare techniques. After acquisition of Areas B and C in 1944 and additional portions of Area A between 1946 and 1952, Detrick Field became formally designated as Fort Detrick in 1956. In 1969, offensive

biological warfare research activities ceased, but defensive biomedical research activities have continued to the present. The NCI-Frederick has been a tenant of the installation since 1972 (Covert 1994). Additional details describing the history of the region are provided in the *Fort Detrick Environmental Planning Guide* (USAG 1998).

4.4.3.1 Historical Sites

The Fort Detrick area is potentially rich in historical sites. The Maryland Provincial Assembly established Frederick County in 1748, and the Town of Frederick was chartered in 1735. Military actions of the French and Indian War, the Revolutionary War, and the Civil War occurred in or near Frederick County (USAG 1998).

Detrick Field had 245 buildings by 1945; however, only 77 of those buildings remain on the installation (USACOE 1997a). All structures built before 1946 have been inventoried and evaluated in the installation's CRMP.

The following Fort Detrick properties are listed on the NRHP: the One-Million-Liter Test Sphere (MLTS) on NCI-Frederick property, and the Nallin Farm Complex, including the Nallin Farm House, bank barn, and springhouse. The Nallin Farm Complex is under consideration as a historic district (USACOE 1997a). The NRHP-listed property closest to the two main USAMRIID buildings is the MLTS, approximately 0.8 kilometers (0.5 miles) distant (USAG 1998, USAMRIID 2000a).

One of the main USAMRIID buildings is eligible for the NRHP. Prior to 1969, this building supported the biological warfare research (BWR) mission, a program that was central to the cold war. An adjacent building that was used to sterilize exhaust air by incineration from the BWR operations is also eligible for the NRHP. Both buildings are considered exceptionally significant as physical examples of the Army's cold war policies, illustrating that aspect of American military history (USAMRIID 2001b).

4.4.3.2 Archaeological Sites

Fort Detrick is located in the Maryland Archaeological Unit 17 known as the Monocacy River Drainage Basin. In accordance with AR 420-40, *Historic Preservation*, and the CRMP, an intensive Phase I Archaeological Survey of Fort Detrick was conducted by USACOE. Approximately 253 hectares (625 acres) of high archaeological potential were identified on Areas A, B, and C during the Phase I investigation, and five sites on Area A were discovered and/or examined (USACOE 1993). Three of these sites are located within about 152 meters (500 feet) of USAMRIID facilities (USAG 1998). Two of them were identified as prehistoric archaeological sites, but they lacked integrity and archaeological research potential (USACOE 1993).

The three archaeological sites near USAMRIID have been identified as significant archaeological sites: the Wide Pastures Farm Site, the Nallin Farm Site, and the Stonewall Jackson Beall Site, in order of increasing distance from USAMRIID RDT&E facilities. Artifacts dated as 19th and 20th century were recovered from the Wide Pastures Site, a 45- by 91-meter (about 150- by 300-foot) area approximately 838 meters (2,750 feet) from the nearest

USAMRIID facility. This property includes the site of the Carriage House, which was destroyed in 1977 (USACOE 1993); the remaining structure was demolished in 2001 (Bennett 2001). At the Nallin Farm Site, 18th- and 19th-century artifacts have been recovered. One piece of pearlware dated between 1780 and 1830 and several 19th-century artifacts were found in the Stonewall Jackson Beall Site, and remnants of historic activity were found in the adjacent yard (USACOE 1993).

4.4.4 Earth Resources

4.4.4.1 Topography

Fort Detrick is located in the Frederick Valley subprovince in the western part of the Piedmont Plateau Physiographic Province (USACOE 2000b). The Piedmont Plateau Physiographic Province extends from the Fall Line, which separates the Coastal Plain and Piedmont Plateau in the east, to the Catoctin Mountains of the Blue Ridge Physiographic Province. Rolling terrain and rather deeply incised stream valleys are representative features of the Piedmont Plateau Physiographic Province (Maryland Department of Natural Resources (MDNR) 1999). Fort Detrick lies in the Frederick Valley, a north-south trending valley that is approximately 42 kilometers (26 miles) long and 9.7 kilometers (6 miles) wide. Directly west of Fort Detrick are the Catoctin Mountains. The Frederick Valley is known as the Frederick syncline, and the Catoctin Mountains are part of an overturned anticline known as the South Mountain Anticlinorium (USACOE 2000b).

Surface elevations within the Piedmont Plateau range from about 30.5 to 305 meters (100 to 1,000 feet) AMSL (MDNR 1999). Elevations at Area A range from about 97.5 meters (320 feet) to more than 121.5 meters (400 feet) AMSL. The main USAMRIID facilities at Area A of Fort Detrick are located at approximately 110 meters (360 feet) AMSL (USGS 1993).

4.4.4.2 Geology

Fractured limestone and dolomite of the Upper Cambrian Age Frederick Formation underlies Area A of Fort Detrick. The Frederick Formation is divided into the Adamstown Member, the Rocky Spring Station Member, and the Lime Kiln Member (USACOE 2000b). Area A is bisected by the Adamstown Member and the Rocky Spring Station Member, which underlie the eastern and western portions of Area A, respectively (USAG 1998).

The geologic formation underlying the two main USAMRIID buildings is the Adamstown Member, which is characterized as a dark gray, uniformly fine-grained, laminated, and thin-bedded limestone, about 333 meters (1,095 feet) thick, with sparse burrows and fauna. Some breccia is found in this formation. The Rocky Spring Station Member, which underlies the other USAMRIID building, is characterized as a thinly bedded limestone, about 300 meters (985 feet) thick, containing dolomite and layers of coarse quartz sand (USAG 1998).

Sinkholes, which are round depressions in the landscape formed by groundwater dissolving limestone or the collapsing of an underlying cavity, commonly occur in the Frederick Formation. Unnatural surface loading in enclosed topographic depressions can create catastrophic sinkholes (USACOE 1997b). According to the *Fort Detrick Photogeologic Analysis Amended Final*

Report, April 2001, there are several sinkhole/depression features on Area A. There are no sinkhole/depression features in the location of USAMRIID buildings (USACOE 2001).

4.4.4.3 Soils

The soils in Area A are described as reddish-brown sandy clay overlying medium to dark gray hard limestone (USDA-SCS 1956). These soils are fertile, highly productive, and manageable (USACOE 2000b) and have the potential to support a variety of vegetation, including grasses, wetland plant species, trees, and agriculture (USAG 1998).

Two types of soil are encountered in Area A of Fort Detrick. The Duffield Silt Loam, with a slope range of 0 to 3%, underlies the western and northern portions of Area A, including most of the USAMRIID facilities. The Duffield/Frankstown Silt Loam, with a slope range of 3 to 8%, underlies the southeastern portion of Area A (USAG 1998). USAMRIID buildings lie on both sides of the dividing line between the two types of soil. Characteristics of the Duffield/Frankstown soil series include deep, well-drained, moderately permeable soils that developed from impure limestone. The Frederick Valley is extensively underlain with Duffield soils (USACOE 2000b), which have low to moderate available water capacity (USDA-SCS 1956). The slightly shallower Frankstown soil contains more shale or cherty gravel (USACOE 2000b).

4.4.4.4 Seismic Activity

Seismic coefficients of 0.03 to 0.07 occur in the Fort Detrick area, which categorizes it as a Seismic Zone 1 area. Characteristics of Seismic Zone 1 include areas that may receive minor damage due to distant earthquakes, such as earthquakes with epicenters in other states (USACOE 1997b, Reger 1987). Maryland has a low probability risk of earthquakes, indicating a very low chance of experiencing a damaging earthquake in a 50-year period (Reger 1987). Forty-seven earthquakes occurred between 1758 and 1993 in the State of Maryland (MGS 2001c).

4.4.5 Land Use

Frederick County encompasses approximately 172,184 hectares (425,472 acres). The primary types of land use in Frederick County include agricultural land/woodland (79.6%), residential land (10.3%), parkland and open space (5.4%), utilities and government land (2.5%), industrial and limited industrial land (1.3%), and commercial land (0.9%) (Frederick County Department of Planning and Zoning 2002).

The City of Frederick covers approximately 4,786 hectares (11,827 acres). Land use within the City of Frederick consists of 41% undeveloped land or woodland; 25.3% residential land; 18.8% institutional land; 8.4% industrial land; and 6.4% commercial land. Fort Detrick is classified as an institution (City of Frederick Planning Department 1995).

Although Fort Detrick is not subject to city or county regulations, regional land use patterns are considered in planning current and future developments at the installation (USAG 1998). Area A is surrounded by the following land use features: low-, medium-, and high-density residential communities, general and office/neighborhood commercial facilities, institutional facilities, limited industrial/trades facilities, and conservation areas.

Development within Fort Detrick has occurred predominantly in Area A. Recreational, agricultural, and natural resource areas and a few RDT&E facilities constitute the land use features in the north and northwest parts of Area A. The eastern portion of Area A includes recreational, agricultural, and natural resource areas with a few communications antenna sites, wetlands, a historical area, and some administrative buildings. In the center of Area A is a training area. The most developed portion of Area A is the southern portion, which includes administrative and industrial buildings, community service facilities, recreational areas, advanced RDT&E complexes, including USAMRIID and NCI-Frederick, and military and family housing (USAG 1998).

The USAMRIID facilities are located in two buildings in the southern portion of Area A and in a U.S. Department of Agriculture (USDA) building (USAMRMC 2001). USAMRIID also operates an animal farm, the LARF, with four buildings located on Area B and a storage barn on Area A (USAMRIID 2000a).

4.4.6 Noise

Significant sources of noise pollution do not exist at Fort Detrick. Minor sources of noise generated at Fort Detrick include the boiler plant, the generator facilities, the carpenter shop, helipad operations, and vehicular traffic (USACOE 1996). The Army Industrial Hygiene department has characterized the noise environment from Fort Detrick's operations and determined it to be compatible with residential use at Fort Detrick (USAG 1998). No significant complaints regarding noise from USAMRIID operations were received from 1991 through 2000 (USAMRIID 2000a).

4.4.7 Socioeconomics and Environmental Justice

4.4.7.1 Economic Activity

Frederick County is the fastest growing county in the Washington metropolitan area. Agriculture, one of the major industries in the county, includes production of ornamental fish, turkeys, and nursery and greenhouse crops. Frederick County is one of the top 75 counties in the country for dairy products. Information technology, manufacturing, and biotechnology are the other important industries in the county (Frederick County Office of Economic Development 2001).

Fort Detrick is the largest employer in Frederick County (Frederick County Department of Planning and Zoning 2000). The military, civilian, and contractor employees at USAMRIID comprise approximately 9.0% of the total employment at Fort Detrick (USAG 2000a, USAMRIID 2000a).

The City of Frederick had an annual average unemployment rate of 2.3% in the year 2000 (Maryland Department of Labor, Licensing and Regulation, Office of Labor Market Analysis and Information 2001).

4.4.7.2 Income

According to 1997 model-based estimates, the median household income in Frederick County was $53,415, and 5.8% of the residents were below the poverty level (U.S. Census Bureau 2001).

4.4.7.3 Population and Demographics

The 2000 population for Frederick County was 195,277, consisting of 89.3% white, 6.4% black, 1.7% Asian, and 0.2% Native Indian/Alaskan Native. Approximately 1.5% are two or more races. The Hispanic population, who may be listed as any race, accounted for 2.4% of the population (U.S. Census Bureau 2001).

4.4.7.4 Housing

In 2000, the median price for a home in Frederick County was $163,000 (Frederick County Chamber of Commerce 2002).

4.4.8 Transportation and Airspace

4.4.8.1 Highways and Roads

Several interstates and highways provide vehicular access to Fort Detrick, including I-70, I-270, USR 15, and USR 40. The nearest exits leading to Fort Detrick include Exit 7 (Rosemont Avenue), Exit 7A (7th Street), and Exit 8 (Opossumtown Pike) off of USR 15.

Area A of Fort Detrick is surrounded by Rosemont Avenue to the west, Opossumtown Pike to the east, Military Road to the southwest, and West 7th Street to the south. There are four access gates to Area A. The main gate is located at the intersection of Military Road and West 7th Street on the south side of the installation. Another gate is located on Rosemont Avenue, near the Montevue Lane intersection on the southwest side of Area A. A third gate is located at the intersection of Opossumtown Pike and Porter Street, on the east side of Area A. The fourth and newest gate is located on the west side of Area A, at the intersection of Rosemont Avenue and Old Farm Road (USAG 1998).

Ground transportation to Fort Detrick is also available by the east-west Blue Route of the Frederick City Bus System (TRANSIT), which stops at the main gate of Area A. The Blue Route also stops at the intersection of Military Road and Rosemont Avenue and at the intersection of Montevue Lane and Rosemont Avenue (USAG 1998).

4.4.8.2 Railroads

Ground transportation via a railway system is available to the City of Frederick. The Brunswick rail line transports passengers from Washington, D.C., located 72.4 kilometers (45 miles) to the south of Fort Detrick. The MARC bus system in downtown Frederick connects passengers to the Brunswick rail line in Point of Rocks, Maryland, and the Blue Route bus service to Fort Detrick (USAG 1998).

4.4.8.3 Airports and Airspace

The Frederick Municipal Airport, located approximately 4.8 kilometers (3 miles) east of Fort Detrick, provides transportation by air. Commercial airline service to the Frederick region is provided by three major airports, BWI (about 87 kilometers [54 miles] to the east), IAD (about 69 kilometers [43 miles] to the southeast), and DCA (about 80 kilometers [50 miles] southeast). The Hagerstown Municipal Airport provides limited commercial passenger and cargo air service and is about 58 kilometers (36 miles) northwest of Fort Detrick (USAG 1998).

Fort Detrick has its own helipad, which is located at Area A. The helipad is used on an infrequent basis for emergency evacuation of medical patients and for transporting very important person (VIP) visitors (USAG 1998).

4.4.8.4 Marine Transportation

Fort Detrick does not border any open bodies of water; therefore, marine transportation to Fort Detrick is not available.

4.4.9 Utilities

4.4.9.1 Water Supply

Both Fort Detrick and the City of Frederick use the Monocacy River as their water supply source. The City of Frederick draws approximately 28% of its drinking water from the Monocacy River, about 7.6 million liters (2 million gallons) per day (Seal 2002). Fort Detrick uses the Monocacy River as its sole source for drinking water and withdraws water at the approximate rate of 5.7 million liters (1.5 million gallons) per day (Grams 2002). The Fort Detrick WTP operates under MDE Water Appropriation and Use Permit No. FR43S001(02), which expires on 1 March 2012 (Fort Detrick, Environmental Office 2002). USAMRIID uses about 227.23 million liters (60.03 million gallons) annually, which is approximately 13% of the total annual water usage for Fort Detrick (about 1,719.7 million liters [454.3 million gallons]) (USAMRIID 2000a). The permit allows an average withdrawal of about 7.6 million liters (2 million gallons) per day of water, with a maximum of about 9.5 million liters (2.5 million gallons) per day of water on peak days (Silvestri 2002). The WTP operates at 62% of its permitted capacity and 29% of its peak treatment capacity.

4.4.9.2 Energy

Fort Detrick obtains its electrical power from the Potomac Edison Power Company, a subsidiary of Allegheny Energy. USAMRIID activities account for approximately 7.5% of the 140,361,000 kilowatt-hours (kWh) per year total consumption by Fort Detrick (USAMRIID 2000a).

USAMRIID heats its facilities using steam generated by the Fort Detrick Central Boiler Plant. USAMRIID accounts for approximately 19.5% of the annual total of about 280,491 metric tons (309,190 tons) of steam for all users at Fort Detrick (USAMRIID 2000a).

The Washington Gas Company provides natural gas to Fort Detrick. USAMRIID consumes an estimated 0.15% of the 6,137,616 ccf[2] of natural gas delivered to the installation annually. Commercial suppliers provide fuel oil and diesel fuel to USAMRIID. Fort Detrick uses about 792,879 liters (209,457 gallons) of fuel oil and about 242,129 liters (63,964 gallons) of diesel per year. USAMRIID accounts for about 5,546 liters (1,465 gallons) per year of the fuel oil (about 0.7% of the total) and 6,178 liters (1,632 gallons) per year of the diesel fuel (about 2.5% of the total) (USAMRIID 2000a).

4.4.10 Water Resources

4.4.10.1 Surface Water

Fort Detrick is located within the Monocacy River Watershed, which covers approximately 192,713 hectares (476,200 acres) (National Watershed Network 2001). Approximately 75% of this watershed lies within the State of Maryland, with the remainder in the State of Pennsylvania. Approximately 75% of land in this watershed is used for agriculture purposes, supporting 3,500 farms. The remaining 25% of land in the watershed consists of forests, the City of Frederick, and residential neighborhoods (Alliance for the Chesapeake Bay 2001).

The Monocacy River flows approximately 1.6 kilometers (1 mile) to the east of Area A of Fort Detrick and discharges into the Potomac River approximately 24.1 kilometers (15 miles) south of the City of Frederick. It ranges from about 0.15 to 5.48 meters (0.5 feet to 18 feet) in depth and from 12.2 to 114.3 meters (40 feet to 375 feet) in width (USAG 1998). Stream discharge rates were recorded for the Monocacy River at Jug Bridge gauging station, located approximately 8 kilometers (5 miles) southeast of the City of Frederick (USGS 2000). The base discharge was about 249 cubic meters (8,800 cubic feet) per second, and the flood stage threshold has an approximate discharge of about 439 cubic meters (15,500 cubic feet) per second (USGS 2000). The discharge rates are highly variable and seasonal, with extremes of approximately 0.5 to 2,311 cubic meters (17 to 81,600 cubic feet) per second at Jug Bridge (USGS 2001b). Although the Monocacy River floods on occasion, the Fort Detrick water and sewage treatment facilities are located in Area C, on elevated grounds adjacent to the floodplain (USAG 1998).

The Monocacy River is a warm-water fishery and has been classified as Recreational Trout Waters and Public Water Use (COMAR 26.08.02) by the State of Maryland (USAG 1998). The classification indicates that the waters are managed as special fisheries by periodic stocking and seasonal catching or have the potential for supporting adult trout populations for put-and-take fishing (Office of the Secretary of State, Division of State Documents 2001). The Monocacy River is also used for drinking water supplies, flood retention, agricultural irrigation, recreational uses, and wildlife habitats (USAG 1998, National Watershed Network 2001).

The water quality of the Monocacy River Watershed is classified as "less serious problems with low vulnerability," which indicates that this river and its tributaries have nutrients in suspended sediment and low dissolved oxygen values, which are caused by nonpoint sources, natural sources, and agriculture (U.S. EPA 2001b). Surface runoff from the City of Frederick also

[2] ccf = 100 cubic feet.

discharges into the river. A high potential for sediment loading in the river exists, especially due to urbanization and agriculture.

Surface water sources at Area A include the Nallin Farm Pond, two unnamed tributaries of the Monocacy River, three storm-water management ponds, and one holding water pond. One unnamed tributary extends south from the Nallin Farm Pond, then turns east, exits the eastern portion of Area A, and discharges 1.6 kilometers (1 mile) east into the Monocacy River (USGS 1993). The 1.3-hectare (3.3-acre) Nallin Farm Pond was formed by the diking of natural springs (USAG 1998). A permit to withdraw water from the Nallin Farm Pond for emergency consumptive uses (MDE Water Appropriation and Use Permit No. FR43S101(01)) was inactivated on 24 April 2000. However, Fort Detrick can use water from the Nallin Farm Pond for emergency firefighting purposes, which does not require a permit (Sheffer 2002). The second unnamed tributary, located 0.6 kilometers (0.4 miles) south of the Nallin Farm Pond, originates in the south central portion of Area A, flows east to the southeastern boundary of Area A through a storm retention pond, exits Area A, and discharges 1.6 kilometers (1 mile) east into the Monocacy River. Two storm-water management ponds and a holding water pond are located in the extreme southern portion of the post. The third storm-water management pond is located in the extreme western portion of the post (DA Directorate of Installation Services (DIS) 2001, USAG et al. 2000).

Storm runoff drains through a system of surface ditches, culverts, inlets, and storm sewer lines at Fort Detrick. The eastern portion of Area A drains into the unnamed tributaries or directly into the Monocacy River. In the vicinity of the main USAMRIID buildings, surface runoff flows into the second unnamed tributary. Storm runoff from the LARF storage barn drains to the adjoining Nallin Farm Pond. The western portion of Area A, including the USDA building that houses USAMRIID facilities, drains into Carroll Creek. The LARF on Area B also drains into Carroll Creek. Carroll Creek, a major tributary to the Monocacy River, originates approximately 3.2 kilometers (2 miles) west of the City of Frederick in the Catoctin Mountains, flows through the areas separating Areas A and B, and ultimately discharges into the Monocacy River (USGS 1993).

4.4.10.2 Groundwater

The Frederick area of the Piedmont Plateau Physiographic Province has the most productive hard rock aquifers within the State of Maryland. Approximately 20% of these formations have the potential to yield 189 liters (50 gallons) per minute or more of water, and water quality is generally good within these aquifers (Maryland Office of Environmental Programs 1986). Groundwater is transported through the carbonate aquifers via bedding planes, fractures, joints, faults, and other partings, which have been enlarged by the dissolution of the carbonate bedrock by acidic recharge (Trapp and Horn 1997). According to the Fort Detrick Photogeologic Analysis, there are several fracture trace/lineament features on Area A, however, this study indicates there are no existing fractures at the locations of USAMRIID facilities (USACOE 2001). There may be a high potential for groundwater contamination if the fracture system underlying Area A is a highly interconnected system (Maryland Office of Environmental Programs 1986).

Wells in the Frederick Limestone Formation typically yield 454 to 644 liters (120 to 170 gallons) per minute (Trapp and Horn 1997). One well within this formation in the southwestern portion of Area A is allowed to withdraw an average of 41,639 liters (11,000 gallons) per day of groundwater. This water is used by the U.S. Army Center for Environmental Health Research (USACEHR) laboratories for research purposes after treatment using activated carbon filters, reverse osmosis, and ultraviolet light and mixing with similarly treated water from the installation water supply system. The mixture of treated domestic water and groundwater is treated once more prior to use in tanks and experiments for aquatic species (USAG 2000b).

A recent remedial investigation at Fort Detrick indicated that groundwater in Area A contained locally elevated concentrations of trichloroethylene (TCE), a suspected carcinogen, and other VOCs. The highest concentrations of TCE were found near a spill site adjoining the USACEHR building (USACOE 2000c). Since Fort Detrick does not use groundwater for drinking water supplies, the presence of these compounds does not pose a health risk to Fort Detrick residents. Residual contamination may affect nearby residential properties that use groundwater for consumption.

4.4.10.3 Wetlands

The INRMP for Fort Detrick serves as a guide for the management and protection of wetlands (USAG 2001). There are three wetland areas on Area A (USFWS 1999a). One of these is located approximately 152 meters (500 feet) from the two main USAMRIID buildings; it was characterized as a temporarily flooded, intermittent, nontidal riverine streambed. The other two wetlands, which are located near the Nallin Farm Complex, were considered as a single watershed in the INRMP (USAG 2001). A small fenced area west of Nallin Farm Pond Drive is a seasonally flooded, persistent, nontidal, palustrine emergent wetland, and a seasonally flooded, broad-leaved deciduous, nontidal, palustrine scrub/shrub wetland (USFWS 1999a). The LARF storage barn is located approximately 152 meters (500 feet) from this wetland. The stream discharging from the Nallin Farm Pond is characterized as a seasonally flooded to saturated, persistent, nontidal, palustrine emergent wetland and a seasonally flooded to saturated, broad-leaved deciduous, nontidal, palustrine scrub/shrub wetland. The LARF storage barn is located approximately 305 meters (1,000 feet) from this wetland (USFWS 1999a).

4.5 Existing Environmental Attributes at Dugway Proving Ground

Dugway Proving Ground (DPG) is located in northwestern Utah, approximately 129 kilometers (80 miles) southwest of Salt Lake City, Utah, and 56 kilometers (35 miles) southwest of Tooele, Utah, as marked on the location map, **Figure 4-4**. DPG is surrounded on three sides by mountain ranges, and its terrain varies from level salt flats to scattered dunes and rugged mountains. DPG covers 323,289 hectares (798,855 acres) within Tooele County. The main CBDP activities are performed on the eastern portion of the installation, between the Cedar Mountains and Granite Peak. About two-thirds of DPG, the western portion, lies within the Great Salt Lake Desert (DPG 1998).

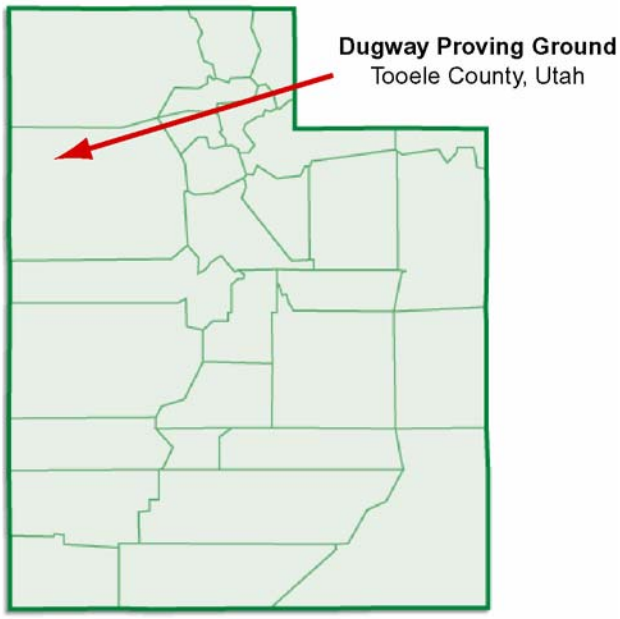

Figure 4-4. Location of Dugway Proving Ground

4.5.1 Air Quality

The local climate is characterized as a mid-latitude dry climate or steppe region with a hot, dry summer, a cool spring and fall, and a moderately cold winter. The maximum temperatures at DPG range from 3.3°C (38°F) in the winter to 34.7°C (94.5°F) in the summer, with an annual average of 18.5°C (65.3°F). The minimum temperatures range from -8.8°C (16.1°F) in winter to 16.2°C (61.2°F) in summer, with an annual average of 3.0°C (37.4°F) (Western Regional Climate Center [WRCC] 2000). Fog is frequent in the winter during high-pressure conditions. The prevailing high-altitude wind is westerly.

Precipitation is sparse, with maximum accumulation from late winter through early spring and minimum accumulation during the summer. The average annual precipitation between 1950 and 2000 was 19.96 centimeters (7.86 inches). The mountain areas receive greater precipitation than the valley floors. The mountain barriers to the west tend to deplete the moisture from storm systems, contributing to the general aridity of the area. The average annual snowfall is

40.1 centimeters (15.8 inches), which falls between November and April. Heavier snowfalls occur in the mountain ranges (WRCC 2000).

Three mountain ranges separate DPG from the higher pollution in Salt Lake Valley. Air pollution from the Salt Lake City area frequently enters Tooele Valley; however, it rarely reaches DPG to the west of Tooele Valley. The air quality is considered excellent and is generally best in summer. Rare exceptions are caused by high concentrations of windblown dust from nearby grazing and agricultural disturbances, especially during dry periods, or by range or forest fires (Wheeler et al. 2000).

The Utah Department of Environmental Quality (UDEQ) monitors air quality. DPG is located in an AQCR designated by UDEQ as in attainment for all applicable NAAQS (Wheeler et al. 2000, U.S. EPA 2001a). The concentrations of all criteria pollutants are below their respective NAAQS levels.

4.5.2 Biological Resources

4.5.2.1 Terrestrial Resources

DPG has a diverse group of plant species that support a variety of wildlife. Three forest and scrub vegetation communities occur at various elevations ranging from low-lying valley floors to the higher altitudes of the Cedar Mountains and Granite Peak, including the Pygmy Forest, high desert scrub, and low desert scrub communities. The Pygmy Forest community is dominated by one tree species, the juniper (*Juniperus osteosperma*), and covers approximately 4% of DPG lands. The high desert scrub community includes greasewood, sagebrush, shrubsteppe, and Great Basin Arid Shrubland species and covers approximately 10% of DPG. The low desert scrub community is dominated by the pickleweed and other grasses (shadscale and gray molly) and covers about 52% of DPG (Directorate of Environmental Programs DPG 2001). In addition, the dunes support a fourth vegetation community, a diverse assemblage of shrubs, grasses, and herbs, which comprise about 1.5% of DPG land area. Groundwater stored in the dunes is available to surficial plants. Annual grasslands cover about 6% of DPG. In the annual grasslands, the exotic annual cheatgrass is dominant over the native vegetation. Tumbling mustard, peppercress, and Russian thistle are also common in the annual grassland. The fifth community is the barren community, which consists of the playa flats, active dunes, and areas void of vegetation. The playa flats cover approximately 25% of DPG acreage and are devoid of vegetation and wildlife except for migrating transients. The active dunes are constantly shifting shape and location due to wind erosion and therefore are not as stable as the vegetative dunes (Directorate of Environmental Programs DPG 2001).

There are 51 species of mammals on DPG, and over half are rodents or rabbits. At the top of the food chain are the carnivorous mammals. The coyote and bobcat are the most numerous carnivores and they utilize most of the installation land. Other carnivores present are the mountain lion, kit fox, and red fox. Other large mammals that live on DPG are the pronghorn, mule deer, and wild horses (Directorate of Environmental Programs DPG 2001).

Smaller mammals on the installation include the longtail weasel, badger, striped skunk, spotted skunk, raccoon, and ringtail. There are 5 families of rodents on DPG. Generally, this includes

the mice, chipmunks, ground squirrels, marmots, kangaroo rats, pocket mice, kangaroo mice, wood rats, desert cottontail, and the black-tailed jackrabbit. These species and the rodents are the primary prey species for the carnivores, with the exception of the mountain lion, which preys on the deer and pronghorn. On DPG, there also are 12 species of bats and 1 species of shrew representing the insectivores (Directorate of Environmental Programs DPG 2001).

Out of the 201 avian species that either reside, breed, or pass through DPG, only 51 species are permanent residents. The raven is the most common bird on the installation. Other common birds at DPG are the black-throated sparrows, house finch, brown-headed cowbird, and Brewer's blackbird. Common raptors include red-tailed hawks, bald eagles, kestrel, prairie falcon, and northern harrier. Nests of 6 species of owls are found at DPG. Canada geese and the ruddy duck are the breeding waterfowl at DPG.

Reptiles and amphibians are also represented at DPG. There are 13 species of reptiles at DPG. The most common are the western fence lizard and the side-blotched lizard. The only amphibian is the spadefoot toad (Wheeler et al. 2000).

4.5.2.2 Aquatic Resources

The arid nature and topography of DPG limit aquatic habitats to only 190 hectares (470 acres). Surface water at DPG is comprised of mostly ephemeral or intermittent flow in natural surface water drainages, natural springs, and man-made impoundments. Surface water is an important resource for wildlife, surrounding vegetation, and migrating birds. Natural surface water features include surface water drainages, springs, ponds, playas, and wetlands. Constructed surface water features include wastewater lagoons, evaporation ponds, an excavated pond, a bermed pond, and roadside ditches (Directorate of Environmental Programs DPG 2001). There are no fish species present on DPG (DPG 2001).

4.5.2.3 Critical Habitats and Species of Special Concern

A number of federally endangered, threatened, and candidate plant and wildlife species, as well as state threatened and endangered species and sensitive species of management consequence, potentially occur or have been documented at DPG.

Federally-listed species include the 3 threatened species (bald eagle, peregrine falcon, and Ute ladies'-tresses); 3 candidates for listing as threatened species (mountain plover, Columbia spotted frog, and Bonneville pondsnail); 1 species proposed for listing (yellow-billed cuckoo); and the pygmy rabbit, which may be the subject of a local effort to propose for listing. State-listed species include 2 endangered species (Fish Springs pondsnail and Utah valatasnail); 3 threatened species (ferruginous hawk, yellow-billed cuckoo, and thickshell pondsnail); 13 species of special concern (Swainson's hawk, northern goshawk, black tern, burrowing owl, short-eared owl, mountain plover, long-billed curlew, chisel-toothed kangaroo rat, ringtail, Townsend's big-eared bat, Utah mountain kingsnake, Utah milksnake, and the Bonneville pondsnail); and 1 conservation species (spotted frog). DPG-listed species (also agency listed by the U.S. Department of the Interior Bureau of Land Management [BLM]) and special status species known to occur on DPG lands include Phol's milkvetch, King's snapdragon, dune four-wing saltbrush, helleborine, Cooper's hymenoxys, ringtail, ferruginous hawk, Swainson's hawk,

golden eagle, gray vireo, sage thrasher, sage sparrow, black-throated sparrow, Brewer's sparrow, and 2 DPG habitat indicator species (kit fox and prairie falcon).

Several areas at DPG are recognized as being unique biological resource areas or as important habitats. The natural springs in the Cedar Mountains are unique as the only permanent open water sources for the wildlife, as well as habitat for riparian specific species. The playa-pickleweed area, an important area for migrating birds, is labeled a special aquatic site because of its special ecological characteristics that could easily be disrupted. Several areas at DPG are recognized as special areas due to their high diversity of plant and animal species or as the only known location of a specific species. Some of these unique vegetation areas are Granite Peak, East Dugway Dunefield, North Baker Sand Island, Southwest Gypsum Dunefield, and the southeast corner of DPG (Directorate of Environmental Programs DPG 2001).

4.5.3 Cultural Resources

DPG's Integrated CRMP states the installation's philosophy and contains standard operating procedures on how cultural resources should be recorded and managed. As of 2001, only about 3% (less than 10,117 hectares [25,000 acres]) of DPG has been inventoried for cultural resources. As the surveys continue, the number of known cultural sites is increasing (Directorate of Environmental Programs DPG 2001).

4.5.3.1 Historical Sites

Historic events and locations in the area of Dugway evolved from early land exploration beginning in 1827, to later travel, mining, and ranching. The Pony Express, which operated from 1860 to 1861, established seven stations immediately south of DPG. The BLM has constructed a replica of the station at Simpson Springs. Station remains also exist at the Lookout Pass, Dugway, Fish Springs, Boyd, and Willow Spring station sites (DPG 1998). In the Dugway Mining District, which was established in the early 1870s, prospecting occurred in the Dugway Mountains and Granite Peak.

The NRHP lists only one historic site located on DPG, the Lincoln Highway Bridge, which is located near the Ditto Technical Center. The bridge dates from 1919 and is one of the few remaining remnants of the first transcontinental highway (Directorate of Environmental Programs DPG 2001). There are also military historic resources, WWII, and cold war facilities on DPG that may be eligible for the NRHP, including test and evaluation facilities, control and instrumentation buildings, a training grid, WWII operational support facilities and developmental laboratories, and nonmilitary sites (Directorate of Environmental Programs DPG 2001). Pre-DPG properties that are potentially eligible for the NRHP include a gold mine and a copper mine within DPG boundaries. The nearest NRHP-listed historic sites outside the installation boundaries are approximately 80.5 kilometers (50 miles) away.

4.5.3.2 Archaeological Sites

DPG is also working with the local Native American tribes to identify sacred sites on the installation. Native American cultures began occupying the site over 11,000 years ago. DPG has over 200 protected archaeological sites where artifacts, including stone implements and pottery shards, have been recovered (DPG 1998).

4.5.4 Earth Resources

4.5.4.1 Topography

DPG is located within the Great Basin Section of the Basin and Range Physiographic Province. This province is characterized by rugged fault block mountains, generally running from north to south, with fairly level intervening valleys. The Cedar Mountains form the northeastern boundary of the installation, ending just north of English Village. The Onaqui Mountains and Davis Mountains lie to the east of DPG. The Deep Creek Range to the west marks the boundary of the Great Salt Lake Desert (USDA 2000, Dynamac Corporation 1992). Granite Mountain has the highest elevation within DPG at 2,158.6 meters (7,082 feet). The other major mountains within DPG include Camels Back, Wig, Simpson Buttes, and Little Granite (Directorate of Environmental Programs DPG 2001).

About two-thirds of DPG, the western portion, lies within the Great Salt Lake Desert. The terrain in the Great Salt Lake Desert is flat with isolated sand dunes and small hills (Wheeler et al. 2000).

4.5.4.2 Geology

Most of the mountain ranges within or adjacent to DPG are composed primarily of Paleozoic sedimentary rocks (conglomerate, limestone, sandstone, and shale) and exposures of volcanic and intrusive Tertiary igneous rocks.

The Great Salt Lake Desert is a prominent feature in the northwest portion of DPG. Much of the DPG test range is dominated by lacustrine deposits, deposited in Lake Bonneville during the Pleistocene period.

Two unique geological features have been identified at DPG (Nature Conservancy 1993). Granite Mountain (west area of DPG) is the only granite intrusive in Utah and has been recognized as the most important natural feature of DPG. The Devil's Postpile, a volcanic intrusive on the southwest slope of the Cedar Mountains, is an excellent example of a columnar basalt feature (Wheeler et al. 2000). Also, several thermal springs are located in the vicinity of the southern boundary of DPG in the Fish Springs National Wildlife Refuge (Directorate of Environmental Programs DPG 2001).

Two mining districts with various ore deposits are located in close proximity to DPG. The Dugway Mining District, south of DPG, includes seven mines or prospects for copper, fluorite, lead, zinc, and/or silver. The Wildcat Mountain Mining District to the north of DPG includes mines containing deposits of fluorite, silver-copper ore, and traces of gold. Saline, silica, undifferentiated gypsum/silica dune deposits, and sand/gravel deposits are among the nonmetallic mineral resources identified at DPG (Directorate of Environmental Programs DPG 2001).

4.5.4.3 Soils

Sixteen soil series have been identified on DPG based on distinct physical and chemical properties that affect their ecological function. The predominant soil series are the Playas (27%), the Playas-Saltair Complex (22%), and the Saltair-Playas Complex (9%). Playas or saline lake

bottoms are developed from the lakebed of historic Lake Bonneville and exhibit deep, saline soils in poorly drained situations (USDA 2000). The soils are strongly calcareous, stratified lake sediments of silt, clay, and sand, with high concentrations of salts that prohibit the growth of vegetation. The Playas-Saltair Complex consists of soils with mainly alluvial and lacustrine origins that are situated on mountains, terraces, alluvial fans, and valley slopes. These soils are well- to moderately drained, slightly alkaline, and usually deep. The Saltair-Playas Complex is a deep and poorly drained soil. This soil series is formed in alluvium and lacustrine sediments derived from mixed rock sources. The other 13 soil series each cover less than 10% of the total area at DPG (Directorate of Environmental Programs DPG 2001).

The soils at DPG are not considered prime farmland due to high alkalinity, high salinity, inadequate precipitation, insufficient water for irrigation, and limited amount of vegetation palatable to livestock. Furthermore, sections of DPG have been classified as severe wind erosion hazard areas.

Cryptobiotic soils have been identified at DPG, distributed throughout several of the vegetative communities. These extremely fragile soils are dominated by cyanobacteria along with lichen, moss, microfungi, and green algae. Cyanobiotic soils form crusts, which allow moisture for plants to accumulate in an otherwise dry environment (Directorate of Environmental Programs DPG 2001).

4.5.4.4 Seismic Activity

DPG lies within a basin area that is part of the Intermountain Seismic Belt. Although Utah is tectonically active, most of the earthquake activity occurs 88.5 kilometers (55 miles) east of DPG along the Wasatach Front. Only one recorded seismic event of a magnitude between 4.0 and 6.0 on the Richter scale has occurred in the DPG area as of 1992. Even though earthquake records and fault maps indicate that the DPG area is a much less active area than the Wasatach Fault Zone, DPG must meet the most stringent building code standards for seismicity (Dynamac Corporation 1992, Wheeler et al. 2000).

4.5.5 Land Use

DPG is surrounded by Tooele County, except along the southern boundary, which abuts portions of Juab County and the Fish Springs National Wildlife Refuge (Dynamac Corporation 1992). Most of the land in Tooele County is owned by the Federal Government (1,480,964 hectares [3,659,502 acres]). Half of the federal lands are administered by BLM for grazing of domestic livestock. The other half is apportioned to DoD, and most of that is a bombing range consisting mostly of salt flats of the Great Salt Lake Desert (USDA 2000).

Much of the remaining Tooele County land is used for agriculture. All the crops are produced on privately owned lands. About 10,522 hectares (26,000 acres) are used for irrigated alfalfa, small grain, and corn silage; 4,047 hectares (10,000 acres) are used for irrigated pasture; and 2,833 hectares (7,000 acres) are used for nonirrigated small grain and alfalfa. The other major agricultural land uses are rangeland and forest. The forest lands are located in parts of the Stansbury and Sheeprock mountain ranges. These areas are the major sources of water in the county, since they receive the heaviest winter snowpack. Other minor acreage is apportioned to

the state, Native American reservations, urban roads and railroads, and small water bodies (USDA 2000).

DPG occupies 319,646 hectares (789,855 acres), with 121 hectares (299 acres) of improved areas used for resident housing and facilities (English Village) and 217 hectares (536 acres) of semi-improved areas associated with test facilities. The remaining land exists in its natural state, except where DPG activities have occurred at firing/bombing ranges, test grids, and training areas (Dynamac Corporation 1992). About 25% of DPG land holdings are designated for training activities. Two outlying areas at DPG are categorized as reserved land or buffer. One of these areas contains active sand dunes, and the other area is a low-lying tract of land northwest of Baker that is subject to periodic flooding.

4.5.6 Noise

Noise at DPG results primarily from aircraft noise and sonic booms from air testing and training activities and from detonations and artillery firing from conventional munitions. Other activities are considered as minimal sources of noise because of the remoteness of DPG. This includes UXO disposal; demolition; construction; environmental remediation; ground training; smoke, obscurant, and illuminant testing; and other testing (USAEHA 1991).

Reliable data and analysis of noise generated from DPG and tenant activities are limited, except for aircraft noise (DPG 2001). Studies using outdoor sound intensity monitors at eight sites throughout DPG found sound levels exceeding the Army's 65 A-weighted decibels (dBAs) goal for day-night average sound levels. Noise levels within DPG office and residential areas were below 55 dBA. The high noise levels were attributed to aircraft, since the noisiest sites were under flight tracks (USAEHA 1991).

4.5.7 Socioeconomics and Environmental Justice

4.5.7.1 Economic Activity

The Federal Government owns over 80% of the land in Tooele County and thus controls a major portion of the range, forest, and mineral resources. The private sector economy is primarily agriculture and mining. Local agriculture consists of farming in the Tooele and Rush valleys east of DPG and some livestock ranching in the Skull valley. Mineral development includes smelting and hardrock mining, primarily for gold, in the eastern portions of the county (Dynamac Corporation 1992).

Private sector employment accounted for more than 70% of the 14,395 jobs in Tooele County in 1998, with earnings totaling approximately $265 million. Government jobs at all levels accounted for approximately 25% of the total. State and local government earnings totaled about $171 million. DPG accounted for a majority of federal civilian and military jobs and is the largest employer in Tooele County (Tooele County Chamber of Commerce and Tourism 2001). The earnings data showed that workers employed in Tooele County but residing elsewhere, including many at DPG, resulted in a greater outflow than the earnings inflow generated by Tooele County residents who worked in other counties (U.S. Bureau of Economic Analysis 2000).

4.5.7.2 Income

According to 1997 model-based estimates from the U.S. Census Bureau, 9.0% of the people in Tooele County were below the poverty level. The median household income in the county was $42,277 (U.S. Census Bureau 2001). Per capita personal income of Tooele County residents was $18,531 in 1998, considerably lower than the statewide ($22,291) and the national ($27,203) values.

4.5.7.3 Population and Demographics

The 2000 population of Tooele County was 40,735 and consisted of 89.2% white, 1.7% Native American and Alaskan Native, 1.3% black, 0.6% Asian, and 0.2% Pacific Islander. Approximately 4.5% were listed as some other race and 2.6% as two or more races. The Hispanic population, who may be listed as any race, accounted for 10.3% of the county population. The year 2000 Dugway CDP population was 2,016, consisting of 63.1% white, 15% black, 8.4% Native American, 2.8% Asian, 0.5% Pacific Islander, and 1.9% listed as some other race. The Hispanic population was 5.8% of the Dugway CDP population (U.S. Census Bureau 2001).

4.5.7.4 Housing

Tooele County has a total of 9,510 housing units, including those on DPG (DPG 2001). Due to its emergence as a suburban commuting location for Salt Lake City, residential development has been very active in the county. In 2001, the median price for a house in Tooele County was $116,500 (Tooele Chamber of Commerce 2001).

English Village is a self-contained residential community at DPG that includes housing for families and unaccompanied personnel and an array of community support facilities. As of December 2000, the DPG housing inventory totaled 512 units.

4.5.8 Transportation and Airspace

4.5.8.1 Highways and Roads

The primary road access to DPG is Utah SR 199, which leads to the main entry gate and security checkpoint located on the eastern boundary. Other gates along the installation perimeter can provide secondary access to remote locations and testing grids.

Regional access to DPG via SR 199 can be accomplished using SR 36, SR 196, and I-80. SR 199 runs across Skull Valley and into Rush Valley, where it intersects with SR 36. This is the primary commuting route for DPG employees living in Tooele County. SR 196 proceeds north from its intersection with SR 199 through Skull Valley for approximately 60 kilometers (37 miles) and connects to I-80 at Rowley Junction. This serves as a truck transportation route to and from DPG, as well as a commuting route (UDOT 2001).

Stark Road is the main traffic artery within the installation. It connects English Village, Ditto, and the areas in the western portion of DPG. Other paved roads branch off from Stark Road and allow access to other activity centers and areas of DPG. There are about 209 kilometers

(130 miles) of paved roadways within DPG, as well as a large network of unpaved roads that provide access to many test ranges and training sites.

4.5.8.2 Railroads

The Union Pacific Railroad is the predominant railroad service in Utah. No direct rail service is provided to DPG, but several lines are located in Tooele County. The main railroad line generally runs east-west and parallels I-80. A second line runs north-south through the Tooele and Rush valleys (Union Pacific Railroad 2001). Activities at DPG typically generate no demand for rail service.

4.5.8.3 Airports and Airspace

Michael Army Airfield (MAAF) is located north of Ditto and Avery on about 275 hectares (680 acres). It has a single runway and a decontamination pad. MAAF supports transportation of test equipment, hazardous cargo, repair parts, and dignitaries. It is also used in DPG test programs and as an aircraft emergency landing site. DPG also has numerous helipads, including one at English Village.

Four other airports are located in the surrounding areas. Hill Air Force Base, an Air Force Materiel Command facility in Ogden, Utah, 194.7 kilometers (121 miles) from DPG, has a single runway that handles over 40,000 takeoffs and landings annually (Hill Air Force Base, Utah 2001). Commercial airline service is available through Salt Lake City International Airport (SLC), located 146.4 kilometers (91 miles) from DPG, which has four runways (SLC 1999). Tooele-Bolinder Field, 101.4 kilometers (63 miles) from DPG, is owned by the Salt Lake City Airport Authority. Wendover Airport, located 193.1 kilometers (120 miles) from DPG, is operated by Tooele County as a general aviation airport and has two runways (AirNav 2001).

Airspace is restricted over and around areas of DPG to maintain the security of activity within the installation. The Utah Test and Training Range has priority of use for the airspace west of Granite Peak and routinely uses it for test and/or training activities for high-performance aircraft. DPG has priority use for the airspace east of Granite Peak and uses it in support of various testing and training activities (Directorate of Environmental Programs DPG 2001, DPG 2001).

4.5.8.4 Marine Transportation

There is no marine transportation at DPG.

4.5.9 Utilities

4.5.9.1 Water Supply

The DPG water supply is obtained from government-owned wells. As of 2000, 10 of the 32 drilled water supply wells at DPG were active. Six of these wells produce potable water, and the other 4 produce nonpotable water for irrigation and other purposes. In addition, 2 wells have been abandoned, and 20 others were inactive but not abandoned. Potable well production averaged approximately 3,406,860 liters (900,000 gallons) per day in 2000. Specific water usage is not known for the CBDP facilities, because the buildings are not individually metered (Pendley 2002a).

The potable water supplies are used by three primary and independent water systems at DPG: English Village Community System, which serves English Village and Fries Park from Wells 26, 27, and 30; Ditto Area System, which serves Ditto, Avery, Baker, and MAAF from Wells 3 and 28; and Carr Area System, which serves Carr from Well 5. Two active nonpotable wells at English Village are used for irrigation of the grounds and the golf course. The other two nonpotable wells, which are located near Granite Peak, are used for dust suppression or sanitary purposes (Directorate of Environmental Programs DPG 2001).

4.5.9.2 Energy

Energy resources used by DPG include electricity, liquid propane gas, fuel oil, and diesel fuel. Utah Power and Light supplied 25,104,000 kWh in 2001. It is roughly estimated that 25% of the electrical power is used for conducting CBDP activities. Fuel oil and liquid propane gas are used to heat the buildings. CBDP activities used approximately 21% of the fuel oil and 11% of the liquid propane gas when compared to the entire installation's fuel consumption (Pendley 2002a). DPG uses a small amount of diesel fuel for emergency backup generators.

4.5.10 Water Resources

4.5.10.1 Surface Water

Surface water is limited at DPG because of the aridity and topography of the region. Permanent surface water sources are limited to very small, spring-fed streams in the Simpson Mountains; ponds at Fish Springs; several small, spring-fed ponds in Skull Valley; and several small rain-filled basins in Dugway Valley. Other than these, there are no permanent surface waters between the Stansbury Range east of DPG and the high Deep Creek Mountains, more than 109 kilometers (68 miles) to the west (Directorate of Environmental Programs DPG 2001, Wheeler et al. 2000).

During heavy precipitation, the clay lake bed underlying the sand dunes restricts the flow of surface water and forms ponds that may be several acres in extent. However, surface water in the desert evaporates and never flows as far as the Great Salt Lake. The quality of the surface water runoff is characterized as fresh, and the water quality of the streams in the vicinity is very high. However, surface water runoff in the western portion of DPG, west of Granite Peak and north of Baker, is characterized as slightly saline to briny. In that area, the salt flats have a clay surface, and the high degree of evaporation results in upward leaching of minerals and surface, deposition (Dynamac Corporation 1992).

DPG contains portions of four surface water drainage areas. Surface water runoff from approximately 3,885 hectares (9,600 acres) of the Skull Valley Drainage Basin predominately flows northeast toward the center of Skull Valley. Surface water runoff from the Dugway Valley–Government Creek Drainage Area (approximately 117,360 hectares [290,000 acres]) and the Fish Springs Drainage Area (approximately 14,569 hectares [36,000 acres]) generally run northwest toward the Great Salt Lake Desert. The western and northwestern portions of DPG (approximately 190,204 hectares [470,000 acres]) lie within the Great Salt Lake Desert Drainage Area, where surface water drainage is internal (Directorate of Environmental Programs DPG 2001).

There are natural and man-made surface water features located at DPG. Natural surface water features include surface water drainages, springs, ponds, playas, and wetlands. Man-made surface water features include wastewater lagoons, evaporation ponds, an excavated pond, a bermed pond, and roadside ditches (Directorate of Environmental Programs DPG 2001).

Floods are extremely rare near DPG due to the climate and topography. Three flood incidents have occurred at DPG since 1942. The 1943-44 and 1952 floods originated in the Government Creek drainage southeast of DPG. The 1952 flood resulted from rapidly melting snow and caused the overflow of Government Creek in the Ditto area. In the third flood (1953), little damage was reported, but the test area was under 2.5 centimeters (1 inch) of water for about a month (Wheeler et al. 2000).

4.5.10.2 Groundwater

DPG is located within a portion of the Great Salt Lake and the Great Salt Lake Desert regional groundwater flow systems. These systems are recharged by water from the mountains and plateaus at the eastern edge of the Basin and Range Physiographic Province and from mountains within the province (Directorate of Environmental Programs DPG 2001). In western Utah, the Basin and Range aquifers generally consist of unconsolidated gravel, sand, silt, and clay or partly consolidated sedimentary or volcanic materials (USGS 2001). Most of the local flow systems that underlie DPG include basin-fill aquifers that are found in Skull Valley and the Dugway Valley–Government Creek area. Overall, the quality of groundwater at DPG is marginal.

The easternmost portion of DPG (English Village area) overlies the Skull Valley aquifer, which is recharged by precipitation that falls mainly on the Stansbury and Onaqui Mountains (Directorate of Environmental Programs DPG 2001). The eastern and central portions of DPG overlie the Dugway Valley–Government Creek aquifer, which consists of saturated older alluvium of the Tertiary and Quaternary Age. Groundwater in this area flows northward under the Ditto and Baker areas toward the Great Salt Lake. Recharge from precipitation flows through the coarse alluvium of higher valleys to lower mountain slopes. Groundwater flow in the Sevier Desert Drainage Basin flows through the Old River Bed, alluvium and colluvium deposits around the flanks of the Simpson Mountains, and older alluvium between the Simpson and Sheeprock Mountains (Directorate of Environmental Programs DPG 2001). Most of this water probably discharges by evaporation from the mud flats and the Great Salt Lake Desert, from the pumping of wells, or from spring discharge (Wheeler et al. 2000).

DPG has 32 wells within the Skull Creek and Dugway Valley-Government Creek aquifers. Of these, the 6 wells currently producing potable water are rated from 1,135.6 to 3,785.4 liters (300 to 1,000 gallons) per minute each. Mean daily potable well production rates were approximately 3,406,860 liters (900,000 gallons) per day in 2000 (Pendley 2002).

4.5.10.3 Wetlands

Several wetland areas have been identified at DPG. The wetlands are at Cane Springs, North Fish Springs, Orr Springs, and a portion of Black's Pond and Mustang Springs (Directorate of Environmental Programs DPG 2001).

4.6 Existing Environmental Attributes at the University of Texas Medical Branch

The University of Texas Medical Branch (UTMB), a campus of the University of Texas, consists of four separate professional schools occupying more than 70 buildings. It is located within the eastern portion of the City of Galveston, Galveston County, Texas, and covers about 34 hectares (84 acres). UTMB was established in 1891 and has more than 2,800 students enrolled and 1,600 faculty as of 2001. **Figure 4-5** is a location map for UTMB.

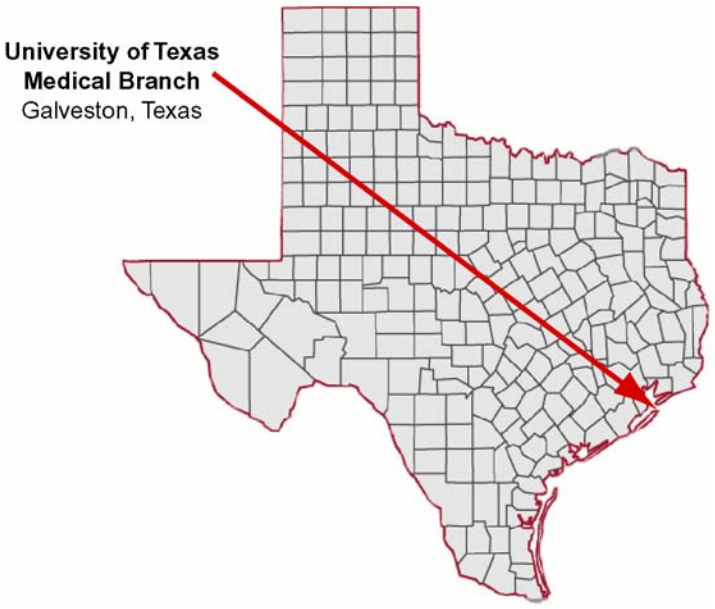

Figure 4-5. Location of the University of Texas Medical Branch

4.6.1 Air Quality

The climate of the south coast of Texas and the Galveston area is characterized by mild temperatures, moderate precipitation, and occasional violent storms that originate over the Gulf of Mexico. Based on a 30-year period from 1961 to 1990, the average annual maximum and minimum temperatures for the City of Galveston were 23.5°C (74.3°F) and 18.3°C (65.0°F), respectively. The monthly average temperature ranges were 14.6°C (58.3°F) (January) to 30.7°C (87.3°F) (July) for the maximums and 8.4°C (47.1°F) (January) to 26.2°C (79.2°F) (July) for the minimums. The extreme highest and lowest recorded temperatures from 1870 to 1993 were 38.3°C (101°F) (July) and -13.3°C (8°F) (February), respectively.

Over a 122-year period, the City of Galveston averaged 96 days of measurable precipitation annually. The total annual precipitation averaged 107.4 centimeters (42.28 inches), with August and September (the hurricane season) as the wettest months. On average, only 0.5 centimeters (0.2 inches) of snowfall occur annually (National Weather Service 2001).

For the period from 1900 to 1993, the average annual wind speed was 17.7 kilometers (11.0 miles) per hour, with average wind speed being fairly consistent for each month of the year (National Weather Service 2001). Maximum winds occur during tropical storms. Forty hurricanes and tropical storms of significant magnitude occurred in the Galveston area between

1870 and 2000 (Hurricanecity 2001). Tornado activity also occurs in the Galveston area; there were 17 tornado events recorded between 1957 and 1995 (The Tornado Project 2001).

The EPA Air Quality Index shows air quality in the Galveston, Texas, city area to be "good," generally. However, Galveston County and the City of Galveston, including UTMB, lie within the Houston/Galveston Ozone Nonattainment Area, as designated by the Texas Natural Resource Conservation Commission and the EPA. Ozone concentrations exceeding its NAAQS limit are attributed to industrial and vehicular emissions of ozone precursors, including VOCs and NO_X. On most days, O_3 is the critical pollutant for this area (TNRCC 2001a). The area is in attainment for other NAAQS criteria pollutants (Odiakosa 2002).

For the Houston-Galveston Ozone Nonattainment Area, Galveston County sources are estimated to contribute 10% of VOC emissions, 11% of NO_x emissions, and 5% of CO emissions (TNRCC 2001b).

4.6.2 Biological Resources

4.6.2.1 Terrestrial Resources

The City of Galveston and UTMB are located on the eastern end of Galveston Island, a 51.5-kilometer-long (32-mile-long) and 3.2-kilometer-wide (2-mile-wide) low coastal barrier island bridged to the mainland over the juncture of Galveston and West Bays (USGS 1994a). Galveston Island, with miles of sand beaches, tidal flats, bayous, and lagoons, is an important tourism and recreation site and provides valuable plant and wildlife habitat. Galveston Island State Park, an 851-hectare (2,103-acre) site opened in 1975, is located on the west end of Galveston Island. The park offers camping, bird watching, nature study, hiking, and swimming. Local fauna includes wading and shore birds, mottled and mallard ducks, raccoons, armadillos, and marsh rabbits (Texas Parks and Wildlife Department 2001).

More than 465 species of birds have been found on the Texas Gulf Coast, which is known as the "funnel of the flyways" (USFWS 1999b).

4.6.2.2 Aquatic Resources

Galveston Bay, a shallow estuary encompassing some 1,554 square kilometers (600 square miles) on the southeast Texas Gulf Coast, is considered to be one of the most productive and important estuaries in the United States (Houston Advanced Research Center 1996). Six primary producer communities are present in Galveston Bay, ranging from phytoplankton (algae) in open bay habitat, to plants in salt and brackish marshes, to trees and perennial plants in the swamps and woodlands bordering the estuary (Texas Department of Water Resources 1981). Several busy shipping channels cross the bay, and industry, urbanization, and agricultural development have affected Galveston Bay and surrounding areas. The Galveston Bay National Estuary Program was established to provide coordinated management and protection for this nationally important resource.

Popular surf fishing species include spotted seatrout, sandtrout, redfish, black drum, croaker, and flounder (Texas Parks and Wildlife Department 2001). In addition, the Galveston Island State

Park Marsh Restoration Project is protecting, restoring, and enhancing 303 hectares (749 acres) of aquatic habitat and wetlands on the west end of Galveston Island (USFWS 1999b).

Several levees and walls, including the Galveston Seawall, have altered the natural environment and today protect residents from flooding. Across the Galveston Channel from the City of Galveston Island is Pelican Island, which is approximately 18.1 square kilometers (7 square miles) in size and largely undeveloped north of the wharves adjacent to the channel and Texas A&M University at Galveston, at the southwest corner of the island.

4.6.2.3 Critical Habitats and Species of Special Concern

The State of Texas Parks and Wildlife (TPW) Department and the USFWS have administrative and legal authority to study, list, and take actions to protect plant and animal species in the Texas coastal region under the Endangered Species Act of 1973 and the TPW Code (31 Texas Administrative Code (TAC) 67 and 68). State endangered and threatened plant species are regulated under 31 TAC 69.1 through 69.9.

As of August 1999, there were 12 species of reptiles and 17 bird species shown on the TPW Annotated List of Rare Species (state and federal) for Galveston County, including the brown pelican (state and federally endangered) and 2 state and federally threatened bird species, the bald eagle and the piping plover. The West Indian Manatee (state and federally endangered) also appears on the same list. In addition, 5 species of plants appear on the list, shown as "rare," but with no regulatory listing status (Texas Parks and Wildlife Department 1999).

There are no federally designated natural areas (e.g., wilderness areas, sanctuaries, wild and scenic rivers) within a 1.6-kilometer (1-mile) radius of UTMB (Environmental Data Resources, Inc. 2002). Two units of the National Wildlife Refuge (NWR) system are found within approximately 29 kilometers (18 miles) of the City of Galveston; Brazoria NWR to the southwest, and Anahuac NWR to the northeast (Rand McNally 2001).

4.6.3 Cultural Resources

The Texas Historical Commission administers the National Historic Preservation Act at the state level through its State Historic Preservation Officer. Other Commission programs include Texas Historic Landmarks and the State Archaeological Landmarks Program (Texas State Historical Association 2002).

4.6.3.1 Historical Sites

Modern historic events and locations in the Galveston area evolved from Spanish and French exploration in the 16th century to the first American involvement in 1815. Galveston has been an important agricultural, fishing, and military port since the mid-19th century. It was the scene of Civil War action, including a dramatic battle in 1863. Galveston continued to prosper until the Great Depression of the 1930s, then began a decline that continued until the 1960s. In the 1970s, preservation efforts began for designating and preserving historic landmarks in the Galveston area (The Texas State Historical Association 2002).

There are 34 historically or architecturally significant buildings on or near the UTMB campus, most of which are within a 914-meter (3,000-foot) radius of the buildings that house, or have housed, CBDP activities. Most of these historic buildings have been rehabilitated in compliance with federal guidelines. All UTMB buildings 45 years of age and older are cataloged with the Texas General Land Office (TGLO) in accordance with Texas Resources Code Sec. 31.160 (UTMB Office of Institutional Analysis 2002). One UTMB campus building that houses biological containment laboratories and animal facilities for CBDP use is registered with TGLO. In addition, six campus buildings registered with TGLO lie within 152 meters (500 feet) of buildings currently in use for CBDP activities (Office of Institutional Analysis UTMB 2002c, USGS 1994a).

Two architecturally significant houses listed in the NRHP are located near the UTMB campus, within approximately 457 meters (1,500 feet) of buildings that house CBDP activities. Other NRHP-listed historic or architectural features that lie within approximately 1.6 kilometers (1 mile) of UTMB include nine historic buildings; the 4.8-kilometer-long (3-mile-long) Galveston Seawall, constructed after the 1900 hurricane; and the 607-hectare (1,500-acre) East-End Historic District (EDR 2002, Texas Historical Commission 2002, USGS 1994a).

4.6.3.2 Archaeological Sites

Archaeological evidence suggests that some Native American groups inhabited the Galveston area as early as 10,000 years ago. Exploitation of marine resources on the coastal margin occurred during the late prehistoric period. Bone-tempered pottery from this time has been excavated at campsites in the Galveston Bay area. An Atakapan burial ground roughly 5,000 years old was discovered approximately 37 kilometers (23 miles) from UTMB near Caplen on the Bolivar peninsula, and flint artifacts were exhumed at the site. Archaeologists have located shell middens begun some time after A.D. 100 and believe many other sites along the shore were damaged or destroyed by winds and tides. Numerous sites inland, small and showing few traces of pottery, suggest that early inhabitants pursued a mobile lifestyle. The Karankawa Indians, a group of five nomadic, linguistically related groups including the Cocos, Cujanes, Karankawas proper, Coapites, and Copanos, later occupied the area, spanning approximately 402 kilometers (250 miles) from Galveston Bay to Corpus Christi Bay in late spring and summer. A Karankawa burial site was discovered approximately 26 kilometers (16 miles) from UTMB at Jamaica Beach in 1962. Other Indian inhabitants included Coahuiltecans, Atakapan-related groups such as the Deadoses and Akokisas, small groups of Lipan Apaches, and, in the 1770s, a Tonkawa group known as the Mayeyes (The Texas State Historical Association 2002, USGS 1994a).

4.6.4 Earth Resources

4.6.4.1 Topography

Galveston Island, the City of Galveston, and the UTMB campus are located within the Coastal Plain Physiographic Province, which is topographically characterized as lowlands, coastlines, and barrier islands indented with small inlets, bays, and marshes (Trapp and Horn 2001). The UTMB campus is located at elevations of 1.5 to 3 meters (5 to 10 feet) AMSL (USGS 1994a).

4.6.4.2 Geology

The geology underlying the Coastal Lowlands Physiographic Province consists of unconsolidated deposits ranging in age from Oligocene to Holocene (Cenozoic Era, Tertiary, and Quaternary systems). These deposits extend from the land surface to depths more than 1,219 meters (4,000 feet) below the surface. Three depositional environments are reflected in the lithology of unconsolidated sediments: alluvial plain (continental); delta, lagoon, and beach (transitional); and continental shelf (marine). The gradual rise of the land surface and dip of the depositional basin results in a wedge-shaped configuration of these depositional environments, which thickens toward the Gulf of Mexico. The heterogeneity of these deposits (an overlapping mixture of sands, silt, and clay) resulted from the oscillations of ancient shorelines (Trapp and Horn 2001).

4.6.4.3 Soils

The major soil association observed on Galveston Island is the Mustang-Galveston Soil Series, which is characterized as deep, nonsaline, nearly level to gently undulating, rapidly permeating, and sandy throughout. The water table is within 0.3 meters (1 foot) of surface in wet areas and within 1.5 meters (5 feet) of surface in dune areas. These soils generally are not suited for crop production, though some areas of the island are used as rangeland. Limitations of these soils for urban development include wetness and wind erosion.

Soils underlying UTMB and much of the City of Galveston are classified as Galveston-Urban Land Complex, indicating the degree of development over native soils. These soils are comprised of fine sand to a depth of 1.5 meters (5 feet) (some of which is dredged material), and are characterized as nonsaline, moderately alkaline, and somewhat excessively drained (15 to 51 centimeters [6 to 20 inches] per hour) (USDA SCS 1986).

4.6.4.4 Seismic Activity

While other regions of Texas have historically recorded earthquakes of magnitudes between 5.5 to 6.0 on the Richter scale, the earthquake hazard is generally low in the Galveston area. However, small earthquakes triggered by oil and gas production have been known to occur there (Texas Department of Public Safety 1998).

4.6.5 Land Use

The City of Galveston, the Galveston County seat, comprises virtually all of the 51.5-kilometer (32-mile) length of Galveston Island (City of Galveston 2002). Agricultural/range lands, wetlands, and forested/barren lands comprise approximately 18%, 9%, and 1% of the county land base, respectively. Approximately 5%, or 16,997 hectares (42,000 acres) of Galveston County is urban/developed land (Coastal Coordination Council 1998). Marine waters (Galveston Bay, West Bay, and the Galveston Channel) make up 68% of the total county area.

4.6.6 Noise

No complaints regarding noise have been reported since 1995 (UTMB 2002a).

4.6.7 Socioeconomics and Environmental Justice

4.6.7.1 Economic Activity

Besides UTMB, the main components of the economy of the City of Galveston and surrounding areas are tourism; outdoor recreation; the Port of Galveston, including the cruise ship terminal; light industry; and insurance companies. UTMB was the third largest employer headquartered in the Houston-Galveston area in 2001. Its contribution to the local business economy is estimated at $163 million (UTMB 2001b).

4.6.7.2 Income

According to 1997 model-based estimates from the U.S. Census Bureau, the median household income in Galveston County was $39,119, and 13.4% of the county population were below the poverty level (U.S. Census Bureau 2001).

4.6.7.3 Population and Demographics

The 2000 population of Galveston County was 217,399, consisting of 72.7% white, 15.4% black, 2.1% Asian, 0.5% Native American and Alaskan Native. Approximately 7.2% were listed as some other race and 2.1% as two or more races. The Hispanic population, who may be listed as any race, accounted for 18.0% of the county total (U.S. Census Bureau 2001).

4.6.7.4 Housing

Median value of owner-occupied housing units in Galveston County in 2000 was $85,200 (U.S. Census Bureau).

4.6.8 Transportation and Airspace

4.6.8.1 Highways and Roads

UTMB is located at the eastern end of the City of Galveston on Galveston Island. The only major highway in the vicinity of the UTMB campus is I-45, which runs north-south, approximately 11.3 kilometers (7 miles) from UTMB. On Galveston Island, I-45 traffic enters Broadway Street (or Avenue J), which is also designated as State Highway 87. The UTMB campus is reached by turning from Broadway heading north onto 6th Street (University Boulevard).

Other ground transportation includes Island Transit and Greyhound Bus lines. Island Transit provides local bus and trolley service for portions of the City of Galveston, including the UTMB campus. Greyhound Bus lines provides intercity service for the City of Galveston.

4.6.8.2 Railroads

Daily passenger rail service between Galveston and Houston is provided by Amtrak. The Galveston Railroad provides freight rail connections at the Port of Galveston for the Burlington Northern Santa Fe Railroad and the Union Pacific Railroad systems (Port of Galveston 2002).

4.6.8.3 Airports and Airspace

Regional airports serving the Galveston area include George Bush Intercontinental Airport on the north side of the Houston metropolitan area, approximately 108 kilometers (67 miles) from UTMB, and William P. Hobby Airport (HOU) in the southeast portion of the City of Houston, approximately 76 kilometers (47 miles) from UTMB. A smaller airport, Ellington Field, is located approximately 10 kilometers (6 miles) southeast of HOU.

Galveston International Airport (Scholes Field) serves private charter and noncommercial aircraft. This airport is located approximately 11.3 kilometers (7 miles) from UTMB, adjoining I-45.

4.6.8.4 Marine Transportation

The Galveston Channel offers ship access to numerous docks, warehouses, and tank farms along the north side of the City of Galveston and the south side of Pelican Island, located less than 0.4 kilometers (0.25 miles) to the north. These facilities are managed by the Port of Galveston. The channel is maintained at a minimum depth of 12.2 meters (40 feet) and an average width of 366 meters (1,200 feet). UTMB is located on the south side of the eastern portion of the channel (Port of Galveston 2002).

The U.S. Coast Guard Group Galveston Base, which is adjacent to Old Fort San Jacinto, lies to the northeast of the UTMB campus at the end of Galveston Island. This is near the confluence of several busy shipping lanes, including the Galveston Channel, the Houston Ship Channel, the Bolivar Roads Channel, and the Inner Bar Channel.

Another important marine transportation link is via the Texas Department of Transportation ferry system between Galveston Island and the Bolivar peninsula, 4.3 kilometers (2.7 miles) to the northeast. Five ferries constitute the system, each capable of carrying 70 vehicles and 500 passengers (Texas DOT 2001).

4.6.9 Utilities

4.6.9.1 Water Supply

Potable water is supplied to the UTMB campus by the City of Galveston Department of Public Works – Municipal Utilities and averages 69,685,535 liters (18,409,028 gallons) per month, with a peak demand of 99,560,471 liters (26,301,176 gallons) per month (UTMB 2001a). Since mid-2001, this water supply has been purchased from Texas City, on the mainland. Surface water from the Brazos River is stored in a reservoir in Texas City prior to being treated, chlorinated, and pumped via pipeline to Galveston Island. Groundwater wells located on the mainland are available to supplement the surface water supply during periods of drought. No water quality problems have been reported since the city converted to this source (Ridenour 2002).

4.6.9.2 Energy

Electrical power for the campus, supplied by Reliant Energy/Houston Lighting and Power, averages 9,399,310 kWh per month, with a peak loading of 11,221,065 kWh per month. Natural

gas provided by Southern Union supplies the UTMB campus, averaging 47,612 ccf[3] per month, with a peak demand of 81,329 ccf per month (UTMB 2001a).

4.6.10 Water Resources

4.6.10.1 Surface Water

Galveston Island is a low barrier island located at the southern end of Galveston Bay, the largest estuary on the Texas coast. The bay is shallow at 2.1 to 2.7 meters (7 to 9 feet) in depth and extends about 48 kilometers (30 miles) north to south and about 27 kilometers (17 miles) east to west. Fresh water from the Trinity and San Jacinto Rivers mixes with tidal salt water from the Gulf of Mexico at the channel between Galveston Island and the Bolivar peninsula (Texas State Historical Association 2002).

Overall, surface water within the Galveston Channel and immediate vicinity of UTMB is characterized as vulnerable to water quality problems. Less than half of Lower Galveston Bay fully supports oyster growth (U.S. EPA Year 2000 305(b) Water Quality Assessment Report), and more than one station exceeds state standards for bacteria 80% of the time (TNRCC 1998). Nonpoint source (overland) water discharges to Lower Galveston Bay are known to contain copper, pathogens, and mercury (U.S. EPA 2001c).

4.6.10.2 Groundwater

Underlying Galveston Island, the City of Galveston, and UTMB is the Coastal Lowlands Aquifer System, which extends along the coastal area from the southern tip of Texas through the states of Louisiana, Mississippi, and Alabama, covering some 90,650 square kilometers (35,000 square miles). This system consists of unconsolidated deposits of the Tertiary and Quaternary Age and yields large quantities of water for public, industrial, and agricultural uses. The lithology is generally sand, silt, and clay. With the exception of shallow zones, the groundwater is under confined conditions. Average hydraulic conductivity is about 6.4 meters (21 feet) per day. The base of the aquifer system is less than 305 vertical meters (1,000 vertical feet) below the Lower Galveston Bay and Galveston Island area (Ryder 2001).

For the coastal lowlands area, in general, high groundwater pumping rates led to significant aquifer drawdown by the early 1980s, for example, 107 vertical meters (350 vertical feet) below the land surface at Houston. The unsustainable degree of pumping caused land subsidence and inland saltwater migration. Groundwater wells on Galveston Island were abandoned by the 1960s because of these concerns. The Harris-Galveston Coastal Subsidence District, which was created in 1975 to address this problem regionally, has resulted in a greater reliance on surface water sources (USGS 1996).

4.6.10.3 Wetlands

The National Wetlands Inventory includes 24 distinct wetland features within 1.6 kilometers (1 mile) of UTMB. However, the waters of the harbor area along the UTMB northern boundary, at their closest encroachment, comprise the only listed wetland feature within 0.4 kilometers (0.25 miles) from UTMB. These waters are classified as excavated, subtidal, unconsolidated

[3] ccf = 100 cubic feet.

bottom, estuarine wetlands. The only wetland located between 0.4 and 0.8 kilometers (between 0.25 and 0.50 miles) from UTMB is classified as a temporarily flooded, persistent, emergent palustrine wetland. The remaining wetlands are between 0.8 and 1.6 kilometers (between 0.50 and 1 mile) from the UTMB campus. Two wetlands in the coastal waters to the south and east of UTMB, approximately 101 meters (330 feet) from the shore, are classified as unconsolidated shore, intertidal marine wetlands. To the southeast of UTMB, between the two aforementioned wetlands, two wetlands are classified as marine. Slightly more than 0.8 kilometers (0.50 miles) to the east of UTMB, approximately 198 meters (650 feet) from the coast, is an emergent, palustrine wetland. Another emergent palustrine wetland is located approximately 1.6 kilometers (1 mile) to the northwest of UTMB. From 1.2 to 1.6 kilometers (0.75 to 1 mile) to the east and northeast of UTMB, 16 small distinct wetland areas (lacustrine, palustrine, and estuarine) are associated with the Old Fort San Jacinto area and the lagoon area to the south (EDR 2002, USGS 1994a).

4.7 Existing Environmental Attributes at the Battelle Memorial Institute, West Jefferson

The Battelle Memorial Institute (BMI) facilities are located near West Jefferson in Madison County, Ohio, approximately 27.4 kilometers (17 miles) east of the City of Columbus, as marked on the location map, **Figure 4-6**. The CBDP facilities are located in the middle and southern portions of the 480-hectare (1,187-acre) property (U.S. DoD 1999).

Figure 4-6. Location of the Battelle Memorial Institute, West Jefferson

4.7.1 Air Quality

The climate of the West Jefferson/Columbus area is characterized as humid and temperate, with cold winters and hot summers (SCS 1981). Mean monthly temperatures range from 23.5°C (74.3°F) in July to -2.2°C (28.0°F) in January (National Weather Service 2002a). Prevailing winds are from the south-southwest.

The average annual precipitation is about 95.5 centimeters (37.6 inches), with monthly averages ranging from about 5 to 10 centimeters (2 to 4 inches) (SCS 1981). The average annual snowfall for the Columbus area is approximately 71 centimeters (27.9 inches) (National Weather Service 2002a). Most of the precipitation, 59% of the annual total, falls between March and August. Thunderstorms happen, on average, about 40 days per year, and severe thunderstorms and tornadoes occur occasionally (SCS 1981). Between 1950 and 1995, eight tornadoes occurred in Madison County. The most severe was a Force 3 tornado that occurred in 1973 (National Weather Service 2002b).

Madison County is located in the Columbus AQCR, which contained a total of 18 ambient air monitoring sites in 2000. Air quality in the county is generally good; it was in attainment for all criteria pollutants in the year 2000 (Ohio EPA 2000). Hazardous air pollutant emissions in the county totaled approximately 387.78 metric tons (427.46 tons) in 1996. The five highest

pollutants were toluene, xylenes, methylene chloride, benzene, and formaldehyde, in order of decreasing tonnage (U.S. EPA 2002b).

4.7.2 Biological Resources

The wooded areas, pasture, agricultural lands, wetlands, and streams in the area provide a diverse habitat for a variety of plant and animal species. Big Darby Creek, which is adjacent to the eastern portion of the BMI West Jefferson site, and its major tributary, Little Darby Creek, have been designated as state scenic rivers. Both streams became part of the National Scenic Rivers program in 1994 (Ohio Division of Natural Areas and Preserves 2001).

4.7.2.1 Terrestrial Resources

The vegetation found in West Jefferson is typical of hardwood forests in the Eastern Corn Belt Plains and includes: American beech, sugar maple, white oak, black oak, northern red oak, yellow poplar, hickory, white ash, and black walnut. Additionally, silver maple, cottonwood, pin oak, sycamore, elm, and sweetgum can be found near streams and rivers (U.S. EPA 1988). Natural areas close to the BMI West Jefferson site are typically comprised of oak, hickory, sycamore, maple, basswood, cottonwood, willow, and ash. The Darby Plains area of Ohio was a tallgrass prairie less than 200 years ago, and some small prairies still exist in Madison County. Some prairie plant species may be found in the area. Other herbaceous plants in the region include grasses and goldenrod (U.S. DoD 1999).

Common game species in the area include whitetail deer, red and grey foxes, cottontail rabbits, and squirrels. Game birds include quail and some ducks. Also assumed to inhabit the area are birds, such as sparrows, cardinals, hawks, geese, herons, and pheasants; animals, including raccoons, woodchucks, and chipmunks; and reptiles and amphibians, including frogs, salamanders, and snakes (ODNR 1998a).

4.7.2.2 Aquatic Resources

Battelle Lake, on the BMI property, supports recreational activities such as fishing for BMI employees. The robust fishery in the lake includes largemouth bass, channel catfish, bluegill sunfish, yellow perch, and black crappie (U.S. DoD 1999). Big Darby Creek and Little Darby Creek are located on the eastern boundary of the BMI West Jefferson site. Together, they are home to 86 species of fish and 41 species of freshwater mollusks (Ohio Division of Natural Areas and Preserves 2001).

4.7.2.3 Critical Habitats and Species of Special Concern

No state-listed rare species of plants or animals or exemplary natural communities are found on the BMI West Jefferson site. The Division of Natural Areas and Preserves of the Ohio Department of Natural Resources is not aware of any geologic features, breeding or nonbreeding animal concentrations, champion trees, state parks, forests, or wildlife areas within 1.6 kilometers (1 mile) of the BMI West Jefferson site, based on a review of Natural Heritage maps and files (ODNR 1998b).

Big Darby Creek provides habitat for endangered/threatened and special status species. Nine endangered/threatened species are found in Big Darby Creek. One fish species, Scioto madtom

(*Noturus trautmani*), and two mollusk species, clubshell (*Pleurobema clava*) and northern riffleshell (*Epioblasma torulosa rangiana*), appear on both the federal and state lists of endangered/threatened species. The State of Ohio's list of endangered/threatened species present in Big Darby Creek includes four other fish species (northern brook lamprey [*Ichthyomyzon fosser*], northern madtom [*Noturus stigmosus*], river redhorse [*Moxostoma carinatum*], and spotted darter [*Etheostoma maculatum*]); two other mollusks (rabbitsfoot [*Quadrula cylindrica cylindrical*] and snuffbox [*Epioblasma triquetra*]); and two plant species (showy lady's-slipper [*Cypripedium reginae*] and two-leaved water-milfoil [*Myriophyllum heterophyllum*]). The State of Ohio also maintains a list of "Special Interest" species, which includes 14 species found in Big Darby Creek, comprising 2 mollusks, wavy-rayed lampmussel (*Lampsilis fasciola*) and round pig-toe (*Pleurobema sintoxia*), and 12 plant species (arbor vitae [*Thuja occidentalis*], grape honeysuckle [*Lonicera reticulata*], green milkweed [*Asclepias viridiflora*], large yellow lady's-slipper [*Cypripedium calceolus var. pubescens*], prairie false indigo [*Baptisia lacteal*], round-leaved dogwood [*Cornus rugosa*], scaly blazing-star [*Liatris squarrosa*], southern hairy rock-cress [*Arabis hirsuta var. adpressipilis*], spider milkweed [*Asclepias viridis*], spotted coral-root [*Corallorhiza maculata*], tall larkspur [*Delphinium exaltatum*], and weak spear-grass [*Poa languida*]) (ODNR 1998b).

4.7.3 Cultural Resources

Protection of historic and cultural resources including historic sites, architecturally important buildings, and unique geological locations is mandated by the National Historic Preservation Act of 1966, as amended (Public Law 89-665), and implemented through NEPA.

4.7.3.1 Historical Sites

There are no known significant historical or cultural resources on or near the BMI West Jefferson site (Epstein 1998).

4.7.3.2 Archaeological Sites

According to the Ohio Historic Preservation Office, there are no significant historic properties listed or eligible for listing in the NRHP within 1.6 kilometers (1 mile) of the BMI West Jefferson site (Epstein 1998).

4.7.4 Earth Resources

4.7.4.1 Topography

Elevations range from about 366 meters (1,200 feet) AMSL in the west-central part of Madison County to less than 244 meters (800 feet) AMSL in the southeastern portion of the county (SCS 1981, ODNR 2001). The BMI West Jefferson site lies at about 274 meters (900 feet) AMSL, and the surface elevation of Battelle Lake is approximately 271 meters (888 feet) AMSL (USGS 1973, USGS 1994b). The property is nearly level.

4.7.4.2 Geology

Basement rocks that were formed during the late Precambrian era about 1 billion years ago lie deep under Ohio. Seas that covered Ohio during the Cambrian period, 500 to 570 million years ago, deposited sandy and calcareous sediments on the basement rocks before receding. Seas of

the Ordovician period deposited clayey and limy sediments in western Ohio 435 to 500 million years ago. Various seas covered portions of Ohio during the Silurian and Devonian periods, depositing carbonate sediments in western Ohio. Later deposits eroded away prior to the Ice Age (ODNR 2001).

Glaciers covered western Ohio at least three times in the last 2 million years, most recently, the Wisconsin glacier. Two major advances of the Wisconsin glacier covered Madison County. Deposits of glacial till, predominantly loam, remained when the glacier receded from the region. Sand and gravel outwash pockets, deposited when the first advance melted, were buried under the glacial till left by the second advance. The terrain of Madison County is characterized by almost level, gently rolling ground moraine and five end moraines that were formed by the retreat and advance of the ice.

4.7.4.3 Soils

Soils in Madison County were derived from the glacial till deposited by the Wisconsin glacier less than 20,000 years ago. West Jefferson lies within the Darby Plains, a large, flat tract of land that is a till plain with an extensive area covered by ground moraine. The Darby Plains are located primarily between Little Darby Creek and Big Darby Creek (ODNR 2001).

Soils underlying the middle portion of the BMI West Jefferson site are of the Crosby-Lewisburg silt loams, which typically have 0 to 2% slopes. This soil unit is 45 to 65% Crosby and 25 to 45% Lewisburg soils. The Crosby soils are typically nearly level and somewhat poorly drained. Crosby soil has a surface layer characterized by dark grayish-brown, friable silt loam, about 25 centimeters (10 inches) thick. The subsoil is a dark yellowish-brown and brown, mottled clay loam, approximately 53 centimeters (21 inches) thick, and yellowish-brown, mottled, firm clay loam substratum extends to about 152 centimeters (60 inches). Carbonates may be found at depths less than 46 centimeters (18 inches). Crosby soil is slowly permeable with moderate to high available water capacity and slow runoff. The seasonal high-water table is found at depths between 30 and 91 centimeters (12 and 36 inches). Lewisburg soil typically has a brown, friable silt loam surface layer, approximately 20 centimeters (8 inches) in depth. The yellowish-brown and dark yellowish-brown, firm clay loam of the subsoil is about 36 centimeters (14 inches) thick. The mottled, yellowish-brown, firm loam substratum extends to about 152 centimeters (60 inches) in depth and is more than 56 centimeters (22 inches) thick in some areas (SCS 1981).

Lewisburg-Celina silt loams are found under the southern portion of the BMI West Jefferson site. They generally have 2 to 6% slopes and typically are moderately well drained and found on ground moraines and end moraines. The unit is generally 40 to 60% Lewisburg silt loam and 25 to 35% Celina silt loam. The surface layer of Celina soil is brown, friable silt loam, about 23 centimeters (9 inches) thick. The subsoil is approximately 43 centimeters (17 inches) thick and is characteristically yellowish-brown in the upper layer and mottled in the lower portion. The substratum is brown and yellowish-brown, mottled, firm clay loam and loam, extending to depths of about 152 centimeters (60 inches) (SCS 1981).

The soil south of the middle area and west of the southern area of the BMI West Jefferson site is nearly level Kokomo silty clay loam, with 0 to 2% slopes. This soil is typically poorly drained and commonly found along or near small intermittent waterways or between low knolls. The

Kokomo soil has a very dark gray, friable silty clay loam surface layer, about 25 centimeters (10 inches) thick. The subsoil is about 56 centimeters (22 inches) thick and composed of firm, mottled clay loam, very dark grayish-brown in the upper layer and dark grayish-brown and grayish-brown in the lower portion. The substratum extends to about 152 centimeters (60 inches) and is characterized by gray and grayish-brown, calcareous, mottled, firm loam. In better-drained areas, the substratum is a calcareous firm loam found at depths of less than 76 centimeters (30 inches) (SCS 1981).

Miamian silt loam (12 to 18% slopes) is found between Battelle Lake and the middle portion of the site, as well as north of the southern area. This type of soil typically occurs between gently sloping uplands and stream terraces, is well drained and has moderately slow permeability and moderately available water capacity. Miamian silt loam is also found at a location south and east of the southern portion of the site, with 18 to 25% slopes (SCS 1981).

4.7.4.4 Seismic Activity

Ohio is on the periphery of the New Madrid Seismic Zone, an area in Missouri and adjacent states that was the site of the largest earthquake sequence to occur in historical times in the continental United States. Seismic risk in Ohio is difficult to assess because of infrequent earthquakes and the fact that active faults do not reach the surface. Additionally, seismic waves in the eastern United States tend to travel very long distances, even for moderate-sized earthquakes, because of the relatively brittle and flat-lying sedimentary rocks in the region that carry the waves throughout thousands of square miles. Studies done in the late 1980s show that west-central Ohio, including Madison County, is underlain by a north-south zone called the Grenville Front, which marks the western edge of a collision zone from the collision of two continents thought to have occurred about 1 billion years ago. None of the faults in Ohio exhibit evidence of movement during recent (Holocene) time, and most have not been active since the Paleozoic era.

Madison County is not known to have been an epicenter for any earthquakes. However, it has felt a number of earthquakes with epicenters elsewhere in Ohio and outside of the state. For example, an earthquake in 1980 centered in Sharpsburg, Kentucky, with a Richter magnitude of 5.3 was strongly felt in Ohio and caused minor to moderate damage to some communities in southwestern Ohio (Ohio Seismic Network 2001).

4.7.5 Land Use

In the year 2000, approximately 87% of the 119,918 total hectares (296,320 total acreage) of Madison County was used for agricultural purposes (Ohio Agricultural Statistics Service 2000). Other land uses in this rural area include residential, industrial, restricted industries, commercial, floodplain, suburban residence, central business, highway business, and community shopping centers.

A residential subdivision is located southwest of the BMI West Jefferson site. A Girl Scout camp is located approximately 610 meters (2,000 feet) from the property, across Big Darby Creek. The 480-hectare (1,187-acre) BMI West Jefferson site includes 329 hectares (814 acres)

leased for agricultural purposes, and Battelle Lake, which is used for recreation by BMI employees (U.S. DoD 1999).

4.7.6 Noise

The only recent complaint regarding noise originating from the BMI West Jefferson site occurred on 12 October 1995. An accidental explosion of the Gas Research Institute pipeline located at the Pipeline Simulation Facility, a BMI facility unrelated to CBDP activities, resulted in loud noise that startled nearby neighbors (U.S. DoD 1999).

4.7.7 Socioeconomics and Environmental Justice

4.7.7.1 Economic Activity

In 1998, Madison County employment sector figures were as follows: 3,164 people in manufacturing; 2,956 in government; 2,548 in trades; 2,184 in services; 592 in construction; 260 in transportation and utilities; and 197 in finance, insurance, and real estate. Although 1998 data were not available for the agricultural, forestry, and fishing industries, data from 1993 to 1997 indicate that approximately 100 people have been employed on farms, not including owner-operators. There were approximately 680 farms with an average size of 159 hectares (394 acres) recorded in Madison County in 1998 (Ohio Department of Development 2002). The Madison County unemployment rate was 3.7% in April 2002 (Ohio Department of Job and Family Services 2002).

4.7.7.2 Income

According to 1997 model-based estimates from the U.S. Census Bureau, the median household income in Madison County was $39,761, and 8.7% of the people in Madison County were below the poverty level (U.S. Census Bureau 2001).

4.7.7.3 Population and Demographics

The 2000 population of Madison County was 40,213, consisting of 91.8% white, 6.2% black, 0.4% Asian, and 0.2% Native American/Alaskan Native. Approximately 0.3% were listed as some other race and 1.0% as two or more races. The Hispanic population, who may be listed as any race, accounted for 0.7% of the total population (U.S. Census Bureau 2001).

4.7.7.4 Housing

In 1998, the average price for a new home in Madison County was $107,224 (Ohio Department of Development 2002).

4.7.8 Transportation and Airspace

4.7.8.1 Highways and Roads

Major highways in the West Jefferson area include I-70, which runs in an east-west direction north of the BMI West Jefferson site, and USR 40 (National Pike), which runs through West Jefferson, south of the site in an east-west direction. SR 142 (Plain City-Georgesville Road) runs north-southwest of the site. The entrance to the BMI West Jefferson site is located about 1.6 kilometers (1 mile) south of I-70 on SR 142.

Greyhound Bus lines serve the Columbus area.

4.7.8.2 Railroads

Amtrak provides passenger rail service to Columbus. CSX Transportation and Norfolk Southern both operate freight lines in the Columbus area (Ohio Central Railroad System 2002).

4.7.8.3 Airports and Airspace

From the BMI West Jefferson site, the Port Columbus International Airport is accessible by automobile via I-70. The airport lies about 43 kilometers (27 miles) from West Jefferson and is served by international and domestic airlines (Columbus Airport Authority 2002). The BMI West Jefferson site is located under the flight path for the Port Columbus International Airport.

4.7.8.4 Marine Transportation

Marine transportation is not available for the BMI West Jefferson site.

4.7.9 Utilities

4.7.9.1 Water Supply

The BMI West Jefferson site operates and maintains its own water supply, under Ohio EPA license No. 98-4930212 (expiration 31 December 2002) for public water supply systems. The sources are three groundwater wells, each approximately 30 meters (100 feet) deep, on the property. The total volume supplied averages approximately 132,489 liters (35,000 gallons) per day (Hampton 2002).

Water for the middle portion of the property is softened prior to use. This water supply is metered and averages approximately 22,157,740 liters (5,853,474 gallons) annually. The water supplied to the southern area is untreated. This water supply, which is not metered, amounts to an estimated 2,973,053 liters (785,400 gallons) of water annually (U.S. DoD 1999).

BMI monitors water quality of the water supplies in accordance with the Safe Drinking Water Laws and regulations under Chapter 6109 of the Ohio Revised Code (Ohio EPA 1996). The results, as reported to the Ohio EPA, show that water quality of the well water supplies has been consistently within federal and state standards.

4.7.9.2 Energy

Electricity for the BMI West Jefferson site is provided by American Electric Power. The average consumption is 281,465 kWh per year, with a peak annual consumption of 412,275 kWh. The average consumption for CBDP activities is 261,104 kWh per year, with peak annual use of 389,924 kWh. Fuel Services Group provides natural gas service to BMI, which consumes an average of 2,804 ccf[4] per year, with a peak consumption of 4,753 ccf per year (BMI 2002).

[4] ccf = 100 cubic feet.

4.7.10 Water Resources

4.7.10.1 Surface Water

Parts of Madison County, including the Village of West Jefferson and the BMI West Jefferson site, lie in the Upper Scioto watershed, the Scioto River basin, and the Ohio River drainage basin. Big Darby Creek, designated by the Nature Conservancy as a "Last Great Place," flows about 152 meters (500 feet) east of the BMI West Jefferson site southward through central Ohio to the Scioto River and drains about 1,442 square kilometers (556.6 square miles). It is an example of a "high-quality ecosystem relatively free of pollution," and because of the diversity of freshwater mussels and fish found in these waters, 132 kilometers (82 miles) of Big Darby Creek and its major tributary, Little Darby Creek, were designated state scenic rivers in 1984 and national scenic rivers in 1994 (National Center for Environmental Assessment 2001). However, this aquatic ecosystem is "currently being threatened by land use changes, which include intensive development along parts of its eastern boundary and losses of riparian zones" (Gordon et al. 2002).

The Upper Scioto watershed is made up of a network of 26 rivers and streams and 274 lakes, totaling 4,540.5 hectares (11,219.6 acres). It was rated under the EPA Index of Watershed Indicators for aquatic resources as "less serious problems," with high vulnerability to pollutants and other stressors. The most common parameters of concern for waters in the Upper Scioto watershed closest to the BMI West Jefferson site that were cited in Ohio's 1998 303(d) impaired waters list are habitat alterations, siltation, and organic enrichment (U.S. EPA 2001d).

Monitoring of Big Darby Creek done by the Ohio EPA between 1979 and 1995 showed it to have high-quality waters with limited nonpoint source impacts in the upper basin. The overall condition of the aquatic community was unchanged in that time span. In the Big Darby Creek watershed, 50 to 75% of the river is in attainment of water quality criteria for aquatic life use. Locations on Big Darby Creek have Index of Biotic Integrity and Invertebrate Community Index (i.e., biological community indices) scores in the exceptional range (Ohio EPA 1996).

Most of Madison County ultimately drains into the Scioto River. The largest drainageway in the county is Deer Creek, which drains areas west and south of the Village of West Jefferson. Little Darby Creek drains the northern portion of Madison County, flows northward into Union County, and then flows southeast past West Jefferson into Big Darby Creek in Franklin County. Paint Creek and small tributaries of Big Darby Creek located south of Plain City drain the remaining portions of Madison County.

4.7.10.2 Groundwater

Central Ohio lies over aquifers of the Central Lowland Physiographic Province. The Mississippian aquifer consists of sandstone and carbonate rock. The more significant Silurian-Devonian aquifer consists primarily of dolomite and limestone. This aquifer extends to about 152 meters (500 feet) below the surface and reaches from western Illinois to central Ohio. Unconsolidated surficial deposits of the Quaternary Age overlie the aquifer in many areas. Water of the surficial aquifer system is typically hard, of a calcium magnesium bicarbonate type, with iron in high concentrations. Groundwater from the Silurian-Devonian aquifer can generally be treated adequately for most water supply purposes. Calcium, magnesium, bicarbonate, and

sulfate are the most common ions found in water samples from western Ohio (Lloyd and Lyke 2002).

Approximately 70% of water used in Madison County comes from public water systems. This includes approximately 1,514,160 liters (400,000 gallons) per day in the Village of West Jefferson (Estadt et al. 2001). For rural households in Madison County, groundwater is the only water source. Private residential wells provide water to 30% of all households in the county. Private water supplies, mostly from groundwater, are used for industry (1,022,058 liters [270,000 gallons] per day) and livestock (1,493,946 liters [394,660 gallons] per day).

4.7.10.3 Wetlands

Battelle Lake, the most prominent wetland in the area, is classified as a lacustrine, limnetic, unconsolidated-bottom, permanently flooded impoundment. Three small palustrine, unconsolidated-bottom, saturated, intermittently exposed, and impounded wetlands are located within approximately 1.6 kilometers (1 mile) of the BMI West Jefferson site. The largest of these covers an area more than 0.4 hectares (1 acre) in size, located within 0.8 kilometers (0.5 miles) from Battelle Lake. The other two are smaller, each covering less than 0.4 hectares (1 acre). One of these smaller wetlands is associated with Silver Ditch northwest of the lake, and the other one is just south of the lake. Two palustrine, temporarily flooded wetlands, both forested in broad-leaved deciduous trees, are located near Big Darby Creek, one north of Battelle Lake and the other further west. Adjoining these wetlands are several additional wetland areas classified as riverine, lower perennial, unconsolidated-bottom, and permanently flooded (USFWS 1995b, USFWS 1993b).